Board of Scientific Advice for India

ANNUAL REPORT

FOR THE YEAR

1916-17

14651

CALCUTTA
SUPERINTENDENT GOVERNMENT PRINTING, INDIA
1918

Price Re. 1 As. 2 or 1s. 9d.

Board of Scientific Advice for India

ANNUAL REPORT

FOR THE YEAR

1916-17

CALCUTTA
SUPERINTENDENT GOVERNMENT PRINTING, INDIA
1918

Price Re. 1 As. 2 or 1s. 9d.

Agents for the Sale of Books Published by the Superintendent of Government Printing, India, Calcutta.

IN EUROPE.

Constable & Co., 10, Orange Street, Leicester Square, London, W.C.

Kegan Paul, Trench, Trübner & Co., 68-74, Carter Lane, E.C., and 25, Museum Street, London, W.C.

Bernard Quaritch, 11, Grafton Street, New Bond Street, London, W.

P. S. King & Sons, 2 & 4, Great Smith Street, Westminster, London, S.W.

H. S. King & Co., 65, Cornhill, E.C., and 9, Pall Mall, London, W.

Grindlay & Co., 54, Parliament Street, London, S.W.

Luzac & Co., 46, Great Russell Street, London, W.C.

W. Thacker & Co., 2, Creed Lane, London, E.C.

T. Fisher Unwin, Ltd., 1, Adelphi Terrace, London, W.C.

Wm. Wesley & Son, 28, Essex Street, Strand, London.

B. H. Blackwell, 50 & 51, Broad Street, Oxford.

Deighton Bell & Co., Ltd., Cambridge.

Oliver and Boyd, Tweeddale Court, Edinburgh.

E. Ponsonby, Ltd., 116, Grafton Street, Dublin.

Ernest Leroux, 28, Rue Bonaparte, Paris.

Martinus Nijhoff, The Hague, Holland.

IN INDIA AND CEYLON.

Thacker, Spink & Co., Calcutta and Simla.

Newman & Co., Calcutta.

R. Cambray & Co., Calcutta.

S. K. Lahiri & Co., Calcutta.

B. Banerjee & Co., Calcutta.

The Indian School Supply Depot, 309, Bow Bazar Street, Calcutta, and 226, Nawabpur, Dacca.

Butterworth & Co. (India), Ltd., Calcutta.

Rai M. C. Sarcar Bahadur & Sons, 90-2-A., Harrison Road, Calcutta.

The Weldon Library, 18-5, Chowringhee Road, Calcutta.

Standard Literature Company, Limited, Calcutta.

Lal Chand & Sons, Calcutta.

Higginbotham & Co., Madras.

V. Kalyanarama Iyer & Co., Madras.

G. A. Natesan & Co., Madras.

S. Murthy & Co., Madras.

Thompson & Co., Madras.

Temple & Co., Madras.

P. R. Rama Iyer & Co., Madras.

Vas & Co., Madras.

E. M. Gopalakrishna Kone, Madura.

Thacker & Co., Ltd., Bombay.

A. J. Combridge & Co., Bombay.

D. B. Taraporevala, Sons & Co., Bombay.

Mrs. Radhabai Atmaram Sagoon, Bombay.

Sunder Pandurang, Bombay.

Gopal Narayan & Co., Bombay.

Ram Chandra Govind & Son, Kalbadevi, Bombay.

A. H. Wheeler & Co., Allahabad, Calcutta and Bombay.

N. B. Mathur, Supt., Nazir Kanun Hind Press, Allahabad.

Rai Sahib M. Gulab Singh & Sons, Mufid-i-Am Press, Lahore and Allahabad.

Rama Krishna and Sons, Lahore.

Supt., American Baptist Mission Press, Rangoon.

Manager, the "Hitavada," Nagpur.

S. C. Talukdar, Proprietor, Students and Co., Cooch Behar.

A. M. & J. Ferguson, Ceylon.

Manager, Educational Book Depots, Nagpur and Jubbulpore.*

Manager of the Imperial Book Depot, 63, Chandney Chauk Street, Delhi.*

Manager, "The Agra Medical Hall and Co-operative Association, Ltd." (Successors to A. John & Co., Agra).*

Supt., Basel Mission Book and Tract Depository, Mangalore.*

P. Varadachary & Co., Madras.*

H. Liddell, Printer, etc., 7, South Road, Allahabad.*

Ram Dayal Agarwala, 184, Katra, Allahabad.*

D. C. Anand & Sons, Peshawar.*

Manager, Newal Kishore Press, Lucknow.*

* Agents for the sale of Legislative Department publications only.

CONTENTS.

Members of the Board of Scientific Advice.

Name.	Appointment.
The Hon'ble Mr. R. A. MANT, B.A., I.C.S.	Secretary to the Government of India (Department of Revenue and Agriculture) and *ex-officio* President, Board of Scientific Advice.
G. T. WALKER, Esq., C.S.I., M.A., Sc.D., F.R.S.	Director-General of Observatories.
N. ANNANDALE, Esq., D.Sc., B.A., C.M.Z.S., F.A.S.B., F.L.S.	Director, Zoological Survey of India.
Colonel Sir SIDNEY BURRARD, K.C.S.I., R.E., F.R.S.	Surveyor-General of India.
Colonel H. T. PEASE, C.I.E., M.R.C.V.S.	Principal, Punjab Veterinary College.
G. S. HART, Esq., C.I.E.	Inspector-General of Forests to the Government of India.
J. MACKENNA, Esq., C.I.E., M.A., I.C.S.	Agricultural Adviser to the Government of India.
H. H. HAYDEN, Esq., C.I.E., F.R.S., D.Sc., B.A., B.A.I. (T.C.D.), F.G.S., F.A.S.B.	Director of the Geological Survey of India.
The Hon'ble Surgeon-General W. R. EDWARDS, C.B., C.M.G., M.D., I.M.S.	Director-General, Indian Medical Service.
The Hon'ble Mr. F. C. ROSE, M.I.C.E.	Secretary to the Government of India, Public Works Department.
Sir ALFRED BOURNE, K.C.I.E., F.R.S.	Director, Indian Institute of Science.
Sir THOMAS HOLLAND, K.C.I.E., F.R.S., F.G.S.	President, Indian Munitions Board.
Lieut.-Col. A. T. GAGE, I.M.S.	Director of the Botanical Survey of India and Secretary, Board of Scientific Advice.

List of Sub-Committees.

Sub-Committee A.—(*Meteorology, Terrestrial Magnetism and cognate subjects*).

1. The Surveyor-General of India (Chairman);
2. The Director-General of Observatories;
3. The Director, Geological Survey of India.

Sub-Committee B.—(*Agricultural Products*).

1. The Director, Botanical Survey of India (Chairman);
2. The Inspector-General of Forests;
3. The Agricultural Adviser to the Government of India.

Sub-Committee C.—(*Soils and Manures*).

1. The Agricultural Adviser to the Government of India (Chairman);
2. The Director, Geological Survey of India;
3. The Inspector-General of Forests.

Sub-Committee D.—(*Forest Products*).

1. The Inspector-General of Forests (Chairman);
2. The Agricultural Adviser to the Government of India;
3. The Director, Botanical Survey of India.

Sub-Committee E.—(*Veterinary Subjects*).

1. The Principal, Punjab Veterinary College (Chairman);
2. The Agricultural Adviser to the Government of India;
3. The Superintendent of the Indian Museum.

Sub-Committee F.—(*Libraries*).

1. The Director-General of Observatories (Chairman);
2. The Surveyor-General of India;
3. The Director, Geological Survey of India;
4. The Superintendent of the Indian Museum.

Annual Report of the Board of Scientific Advice for India, 1916-1917.

SUMMARY OF PROCEEDINGS.

Thirty-second Meeting held at Simla on the 14th May 1917.

The Board considered and accepted the programmes of the various Scientific Departments for the year 1917-18.

It was resolved that in future the programmes submitted to the Board should be as brief as possible, and that the provincial programmes of the *Agricultural Department are not* required by the Board.

The question of the Annual Report of the Board was also discussed and it was decided that it should consist of a brief statement of work done in each Department with a complete list of year's publications bearing on the subject.

The Board considered a letter from the Surveyor-General of India, submitting a report of the meeting of the Science Congress held at Bangalore on the Scientific Libraries in India. As it was understood that the Government of India in the Education Department were taking the necessary steps, this report was recorded.

The question of the re-organisation of the Board was then considered. The Board was of opinion that at present the only change necessary is the addition to its members of a representative of the Munitions Board. It was also resolved that for the purpose of particular investigations sub-committees should be appointed consisting of such members of the Board as are called by the President, and that membership of these sub-committees need not be confined to members of the Board.

Thirty-third Meeting held at Delhi on the 19th November 1917.

The draft Annual Report of the Board for 1916-17 was considered. It was resolved that the lists of publications should be transferred to the end of the volume. In other respects the Board approved the report and decided that in future the Sectional Reports should not exceed 4 pages, apart from the Bibliography. Col. Pease suggested that *resumés* of articles mentioned in the Bibliography which are likely to be of use to Veterinary officers in the districts, be published half-yearly. It was decided that this suggestion be passed on to the Agricultural Adviser to the Government of India.

It was resolved that the President and the Secretary should be authorised to dispose of questions of change in the Distribution List, and that it is unnecessary to print and circulate the list.

APPLIED CHEMISTRY.

PART I.—AGRICULTURAL CHEMISTRY

BY

W. A. DAVIS, B.Sc., A.C.C.I., F.C.S.,

Officiating Imperial Agricultural Chemist.

SOILS.

Assam soils.—Meggitt reports that permanent field experiments as to *the economic use and effect of certain manures on the sour old alluvial soils* of the Assam valley have been continued in their 6th year. Certain well marked results may now be dealt with.

(1) The paramount importance of a base preferably as lime or as calcium carbonate. Even complete mixtures of manures are devoid of effect unless the soil acidity is first more or less completely neutralised.

(2) For the best results certain crops require that in certain soils the acidity shall be more completely neutralised than in others. The degree and depth to which soil acidity is neutralised depends on the depth of cultivation and of course on the amount of lime applied. In determining the amount and depth of lime application the three chief factors to be considered are (*a*) the lime requirements of the soil as indicated by laboratory methods ; (*b*) the rooting habits of the crop ; (*c*) the crop's relative immunity to acidity, particularly in the early stages of growth.

(3) Next to the addition of a base, phosphoric acid is the element of plant food most required by these sour soils. This is best applied, not as superphosphate unless in conjunction with liming, but in a basic form such as basic slag or certain raw mineral phosphates, some of which give results comparable to those of basic slag. In the absence of phosphoric acid in the mixture, even on limed plots, the effect of adding potash or nitrogen is extremely small.

(4) The continued use of superphosphate or sulphate of ammonia on unlimed land is absolutely detrimental to most farm crops and even when lime is applied the use of sulphate of ammonia rather than nitrate of soda is clearly uneconomical.

Bihar.—Davis has drawn attention to the extraordinarily low values of available phosphate in the soils of many indigo estates in Bihar; in the majority of these the available phosphate is of the order 0·0002 to 0·0005 per cent., that is from 1-50th to 1-20th, the amount generally regarded as necessary for fertility (0·01 per cent.). It is shown that the diagnosis of phosphatic deficiency revealed by analysis is confirmed by actual manurial trials. For example on the Pusa experimental plots, where the addition of superphosphate alone gives practically the same result as farmyard manure containing the same amount of phosphoric acid, addition of nitrogen or potash without superphosphate has little effect and even when applied in conjunction with superphosphate, they do not increase the yield beyond that reached with superphosphate alone. On the other hand at Pusa green manuring combined with superphosphate gave far higher results than either superphosphate alone or green manure alone. It is suggested that the phosphate deficiency in the Bihar soils limits the crop not merely by withholding an essential constituent of growth but also by preventing the proper development of soil bacteria for the nutrition of which a phosphatic medium is necessary.

A systematic survey of the soils of Bihar is being undertaken and manurial experiments with superphosphate are being made on several indigo estates.

Bengal.—Finlow reports that a soil survey of the province has been commenced in the laboratory at Dacca and interesting results are already accruing. The red laterite clay soils of the old alluvium in Eastern Bengal show a striking lack of lime and phosphate and while the total potash averages as much as 0·3 per cent. it is practically unavailable until lime has been applied. Field tests have shown that without either application of potash manures or very heavy general manuring jute suffers from *Rhizoctonia* in these soils if grown oftener than once in 3 years, even on land which has been limed.

The soils of those tracts of the new alluvium, which receive the silt of the great rivers are much richer than the red soils. They contain little or no free carbonate but they are very rich in total potash, some containing over 1 per cent. of this constituent. This is in striking contrast to the red soils and probably accounts for the excellent crops of jute which they grow year after year. On the other hand they are normally deficient in phosphoric acid, so that possible deterioration of the soil from depletion of this constituent should be watched.

The portions of the new alluvium, *e.g.*, Rangpur (North Bengal) and Rajshahi (West Bengal) which are not inundated by the annual river floods are inclined to be sandy in the high lands. They differ considerably from each other both in potash content and in lime; some of the soils contain very little of the former constituent, others are richer. Some soils contain up to 3 per cent. of calcium carbonate, in others it is almost absent. All these soils are normally deficient in phosphoric acid. These soils often overlie the red soil at no great depth, *e.g.*, at Jamalpur (Mymensingh).

Biochemical factors in reclamation of alkali soils.—Barnes has published an important paper on this subject. He has made use of the methods suggested by Hutchinson for measuring the biochemical activity of saline soils as a means of following the changes in salt-soils during the process of reclamation by washing. The barrenness of salt soils is probably due to the high osmotic pressure of the soil solution in such cases due to dissolved salts. This osmotic pressure interferes with the bacterial activity more or less proportionately to its plasmolytic effect on the cells of the living plant. The measurements of bacterial activity therefore can be used as a rapid method of recognizing the necessity in the case of saline soils of special treatment to impart fertility and also as a means of gauging the exact amount of washing necessary before such treated lands are put under crops. Several interesting points arise from these experiments, particularly the fact that in salt soils the nitrifying organisms are present but are in a dormant condition. Washing of the soils is followed by increased nitrification. The ammonifying organisms appear to be more resistant to saline matter than the nitrifying organisms so that in certain sterile patches considerable ammonification may occur without any corresponding transformation into nitrates. Actual data are given showing the improvement of biochemical character of the soil during successive stages of reclamation.

Infertility under trees.—It is well known that trees often give rise to infertile patches in their neighbourhood. Several causes may co-operate to this end and the question has been discussed in some detail by Sen. It is shown that several trees especially the bamboo and tamarind bring about a concentration of soluble salts in the upper layers of the soil in their neighbourhood probably owing to transpiration. As a rule "good" soils in the neighbourhood of trees, that is soils which were still relatively fertile, were generally found to contain less than 0·3 per cent. of soluble salts, but bad soils, where growth was poor, often contained more than 0·5 per cent. The nature of the soluble salts, however, greatly modifies the effect in limiting fertility.

The connection between Soil Deficiency and Plant and Animal Disease.—Finlow reports that at Dacca the incidence of Rhizoctonia in jute appears to be associated with lack of potash. Part of land which had grown jute for 2 years was manured with potash and part was not so treated. In the former, which received potash the jute remained healthy and in the latter the plants are dying out wholesale from Rhizoctonia. These results confirm similar observations made during the past 3 years.

Davis has attributed mainly to phosphate starvation the ravages of the so-called "wilt" disease of indigo in Bihar and suggests that this same cause, by influencing the composition of the fodder grown thereon, may be responsible for the low milk yield of cattle in this province and the prevalence of nervous diseases such as *Kumri* in horses. It is suggested that the latter is really a deficiency disease, similar in its nature to beri-beri, scurvy, *pellagra*

and polyneuritis. This explanation is in harmony with Macalister's recent work at Muktesar on this disease which shows that all previous theories as to a causal agent are unsatisfactory. Macalister concludes in fact that the causal agent must be sought for in the forage. From Sen's recent analyses it appears that the rices of Bihar are deficient in phosphoric acid as compared with rice grown on soils containing a larger proportion of phosphate and are thus lacking in a very essential element of nutrition. This deficiency constitutes a possible danger in the future and may lead to the spread among inhabitants of certain deficiency diseases such as beri-beri which are apparently due to malnutrition.

The connection existing between soil composition and the spread of fungal pests is a subject which hitherto has hardly received sufficient attention in India but undoubtedly should be studied carefully in the future. It is well known in the case of English crops that diseases such as rust will develop in wheat on plots where there is starvation of one essential constituent such as potash or phosphoric acid, whereas on completely manured plots although immediately alongside there is practically no disease. In other cases such as root crops or potatoes, fungal diseases appear when the proportion of potash or phosphoric acid to the nitrogen in the soil is low so that there is an abnormal metabolism in the plant. The same tendency to fungal disease is found in the Rothamsted grass plots which receive nitrogen but no potash.

The view that soil depletion may also tend to spread the ravages of insect pests appears very probable not only on general grounds but also in view of recent experience in India. Thus Andrews has recently associated the mosquito blight of tea with a high ratio of phosphoric acid to potash in the soil and has stated that when in certain gardens the ratio of potash to phosphoric acid was high mosquito blight was unknown, but that it has gradually increased as the ratio between the two available constituents decreased. In the case of indigo in Bihar the spread of the *Psylla* pest has become very marked in recent years and the ravages of the insect seem to have increased simultaneously with the spread of the so-called " wilt," which is neither a bacterial nor fungal disease and is probably essentially starvation of the plant due to the abnormal deficiency of Bihar soils in available phosphate.

That the deficiency of one constituent in the soil may render a special plant grown on it more susceptible to fungal or insect attack than the same plant grown in a normal soil can easily be understood when the special importance of one or other of the elements of the soil solution in the plant's metabolism is recalled. A relative deficiency of one element would result in an abnormal metabolism and possibly the production of some substance (such as indole in the indigo plant) which exercises a strong attraction for the insect or fungal pest or the lack of production of some protective principle which renders the healthy plant more or less immune to attack. There is a wide field for work on the connection existing between the chemical and physical character of soils and the nature of plant diseases prevalent thereon.

Soil analysis.—Sen has drawn attention to the lowering in the values for available phosphate in soils as determined by Dyer's method which occurs when increasing proportions of calcium carbonate are added. This falling off is no doubt mainly to be attributed to the neutralization of the citric acid, which takes place in stages as the successive carboxyl groups are affected; the maximum effect is seen when 5 to 10 grms. of calcium carbonate are added, that is towards the completion of the neutralization, but the effect persists even when more than sufficient calcium carbonate is present for complete neutralization, probably owing to an adsorption effect. Attention is drawn to the difficulty which these facts present to accepting available phosphate values in the case of highly calcareous soils. But as the writer has pointed out in a note to this paper, it is actually in the case of calcareous soils that Dyer's method as a rule gives the most useful *practical* diagnostic indications. This is probably due to the fact that in such cases the action of the soil acids produced by bacterial or other influences, in liberating "available" phosphate in the soil, is most interfered with owing to neutralization. So that *there still is a parallelism between* the low values for available phosphate obtained by Dyer's method and the actual amount of phosphate available for food in the soil. It is actually found in practice that those calcareous soils which give the lowest values for the available phosphate by Dyer's method, are the most responsive to manuring with superphosphate. So that Dyer's method, whether it is an absolute measure of the "available" phosphate or only an indication of the neutralization of the soil acids which bring phosphate into solution, as a rule remains one of the most useful practical methods of judging soil fertility.

MANURES.

Finlow reports that investigations as to the possibility of utilizing the *Water Hyacinth* (*Eichornia crassipes*), which is a serious pest in Bengal, Burma, Madras, the Malay States, Cochin China, Australia and Egypt, have shown that a portion of the cost of eradication can be recovered by making use of ash of the burnt plant as a potash manure. Some samples of the ash of this plant contain as much as 35 per cent. K_2O as potassium chloride, that is equivalent to first class kelp minus the iodine of the latter. The minimum of K_2O found in the ash is about 10 per cent. In field tests at Dacca in 1916, the ash applied in equivalent quantities was found to exercise the same extraordinarily favourable effect on jute as salts of potash have been shown to possess, and the plots which received potash yielded 25 per cent. more than those not so treated. Messrs. Shaw Wallace offer to buy any quantity of the ash at a price of R4 per unit of potash and in January 1917, 10,000 leaflets were issued in Bengali containing information to this effect. In the succeeding six months about 270 tons of ash have been produced by the public and sold as a manure. This represents a destruction of about 27,000 tons of green plant.

WATER SUPPLY.

Barnes has published work on the chalybeate waters from tube wells in the Punjab and their significance to the municipal engineer and manufacturer. The presence of iron in such waters is attended by several grave disadvantages. Although the iron, even in the more heavily impregnated waters, is unlikely detrimentally to affect the public health, the turbidity of the water and the constant staining of glass and other vessels used for storage, leads to uneasiness on the part of the public as to its purity and suitability for drinking purposes. In the bleaching and dyeing of cotton and also in paper manufacture the presence of iron is highly objectionable. Of all the methods for the removal of iron the Candy filter appears to be the most suitable in Northern India. Its maintenance cost is low, no precipitant is needed and it can be easily cleaned. Oxidation is effected by means of a layer of "*oxidium*," a catalytic oxidizer, consisting of a porous composition of iron oxide, silica, lime and magnesia. The bacterial efficiency of this filter is also satisfactory. In the Punjab well-waters Barnes has identified the following bacteria :—(1) *Leptothrix ochracea*, (2) *Gallionella ferruginea*, (3) *Spirophyllum ferrugineum*, (4) *Crenothrix polyspora*.

SUGAR.

Cane sugar.—Barnes has published an interesting paper on the after-ripening of the cane and the chemical changes which take place after cutting. Storing cut cane before crushing tends to further ripening but is attended with danger of losing sugar if the storage is too prolonged. The length of time during which cane can be stored without causing loss of sugar and in which an actual increase of saccharose from reducing sugar takes place, will vary with the temperature of the air and the condition of the cane. The higher the temperature the shorter should be the time of storage. Excessive cold on the other hand, or a sudden fall of temperature may also cause a loss of saccharose. The Java system of covering cut cane with damp trash is to keep the stem alive. By this treatment the cane will be maintained at a uniform temperature and being in a moist atmosphere will not lose water. For a limited time there should be an increase rather than a decrease in the saccharose content of the cane. On the other hand moist heat will not only increase the moulds, fungi and bacteria, all of which bring about rapid destruction of sugar, but, once the cell is dead, will induce rapid decay of the cell contents by enzymic action.

Venkataraman and Krishnamurthi Row have studied the variation in the saccharose content in successive cane joints at different periods of growth. Their analyses show that in a very immature cane the highest sucrose content is found in the lowest section but as the cane advances in maturity the region of highest saccharose content gradually moves upwards. When a cane is left growing in the ground after it has attained maturity it shows rapid deterioration at the basal joints. The highest saccharose reading obtained by sectional

analyses of any particular variety probably represents the highest saccharose content that the variety is capable of containing under the given conditions and to this value the name " sucrose index " of the cane is given. It appears to be fairly constant for each variety or seedling and will enable a comparison to be made between different seedlings even when they are immature.

Palm sugar.—Annett has obtained some important practical results in the course of his study of the palm sugar industry. The usual country method of smoking the pots before placing them to catch the juice has a distinctly beneficial effect in preserving the juice, the saccharose of which is very liable to undergo inversion by enzymes and micro-organisms and so yield a product which does not readily crystallize. The Bengal tapper wastes practically the whole of the juice which falls from the tree during the day time as during this period the temperature is high and the juice undergoes so much inversion that it fails to yield a good crystalline sugar. By the simple device of rubbing the inside of the pots with lime cream however, the inversion can almost entirely be prevented and the sugar obtained from the limed gur is much whiter than from ordinary gur. By adopting this practice the cultivator would increase the outturn of gur by more than 20 per cent. When date palm juice is kept in pots which have been limed, the proportion of non-crystallisable sugars greatly diminishes.

The dark colour of date palm gur is largely due to the fact that the fresh juice is alkaline. When the juice is concentrated the alkaline matters act on the reducing sugars, especially the levulose, and give rise to dark coloured substances. If the juice is very slightly acidified before boiling a perfectly light coloured gur is obtained.

OPIUM.

Much work has been accomplished during the past year at Cawnpore by Leake and Annett on the improvement of Indian opium. Only the chemical results of this investigation, obtained by Annett, will be referred to in this place. The object aimed at has been to find out the cause of the low morphine content of Indian opium which largely prevents its use in the manufacture of the opium alkaloids for medical purposes. The results so far obtained may be briefly summarized.

(1) The mineral manures, nitrate of soda, superphosphate and sulphate of potash have shown no effect in modifying the alkaloidal content, but at the same time nitrate of soda gave large increases in the total opium. Superphosphate exercises a marked beneficial effect in encouraging growth in the early stages.

(2) Climate and altitude seem to exercise no effect on the alkaloidal content of the opium, as judged by experiments with the same pure race of poppy grown in the plains and at various stations in the Himalayas.

(3) Different races of poppies show important differences in their alkaloidal content.

(4) Much work has been done in the direction of devising accurate polarimetric methods for the estimation of morphine and codeine in opium.

JUTE.

Finlow has made a special study of the "heart-damage" of baled jute which shows that the damage arises from baling the jute in too damp a condition. Genuine jute cannot absorb sufficient moisture in a legitimate way to enable it to undergo "heart-damage" which occurs in 400 lb. bales only when they contain more than 25 per cent. of moisture. In smaller bales 280 lb. where the pressure is less, over 30 per cent. of water is necessary for "heart-damage" to occur.

Heart-damage takes place first at the centre of the mass of fibres in which it occurs and is accompanied by a rise of temperature of the bale to over 40°. It is caused by bacteria the optimum temperature of which is about 40°, and cultures have been obtained from damaged jute which produce all the typical effects of "heart-damage." The damaged fibres lose all tensile strength and are therefore useless for spinnning; chemically over 30 per cent. of the cellulose is destroyed by the fermentation.

MISCELLANEOUS.

Enzymes of red gram.—B. Viswanath has published a paper on the enzymes of germinating red gram (*Cajanus indicus*) which shows that an aqueous extract of germinated dholl contains ereptase, amylase, cytase, maltase, invertase, lipase, urease and an oxidase. No peptase is present in the normal seed and the hydrolysis of the reserve protein takes place at a much later stage in germination. Whether this hydrolysis is due to protoplasmic activity or to the secretion of a separate enzyme is still doubtful.

Milk supply.—Warth has published a bulletin on the Mandalay milk supply, with detailed analyses, which show serious adulteration in some cases with 8 times its weight of water. At the present time the price charged for most of the milk is excessive compared with its real value and it is recommended that the Co-operative Department take steps to put the supply on a better basis.

Feeding Stuffs.—Sen has has prepared a *Bulletin* (No. 70 of the Agricultural Research Institute, Pusa), summarising the analyses of numerous feeding stuffs received of recent years in the Laboratory of the Imperial Agricultural Chemist, Pusa. This should be useful to those maintaining cattle and horses as it gives data for the feeding values of most of the Indian feeding stuffs.

APPLIED CHEMISTRY.

PART II.—FOREST CHEMISTRY

BY

PURAN SINGH, F.C.S.,

Chemical Adviser to Forest Research Institute.

The following is a brief account of the more important work carried out by the Chemical Department of the Forest Research Institute during the year 1916-17.

ESSENTIAL OILS AND OLEO-RESINS.

Boswellia serrata gum-resin and its products.—It has already been shown that the Boswellia turpentine and resin are valuable products. Some work was done during this year to suggest new industrial uses for the gum which is a bye-product of the Boswellia turpentine distillation. The Chemical Adviser has suggested that it would be useful material in the paper mills for sizing purposes. This suggestion having been further confirmed by Mr. W. Raitt, the Cellulose Expert to the Institute, a sample of 100 lbs. of the gum has been sent by the Forest Economist to Titagarh Papermills for a trial.

The oil of Blumea Malcolmii.—As mentioned in the last year's report this new oil was under study. A study of its chemical constituents has now been completed. There is no Pulegone in the oil as was shown by the preliminary work. The main constituent of the oil is Dextro-carvone with a small quantity of menthone. A paper on the subject is under preparation.

The oil of Skimmia Laureola.—An essential oil of some value has been distilled from the green leaves of *Skimmia laureola* during the year. It is also a new oil and the study of its chemical constituents is in progress.

Distillation of Cymbopogon species from Burma.—The samples of Burma Cymbopogon grasses were received from Burma and distilled during the year. The following table gives the precentage of oil obtained and their constants.

DESCRIPTION.	Moisture per cent.	Oil per cent.	Oil calculated per dry material per cent.	CONSTANTS OF THE OILS.								
				Colour.	Sp. Gr. at 150°C.	Length of rotation.	Refractive index at 30°C.	Acid No.	Saponification No. before acetylisation.	Saponification No. after acetylisation.	Soluble in 70 per cent. alcohol.	Soluble in 80 per cent. alcohol.
Cymbopogon grass from Maymyo, mostly flower heads.	9·62	0·13	0·14	Yellow brown.	0·9376	+43°57′36″	1·4860	1·13	36·98	210·4	2·1 parts.	1·1 parts.
Cymbopogon grass from Thayetmyo, mostly leaf-stalk devoid of flowers.	11·27	0·99	1·12	Light yellow.	0·9303	—3°23′24″	1·4850	0·84	25·6	182·6	2·4 parts.	1·2 parts.

From these constants it is evident that the oils from Burma Cymbopogon are to be classed with the Indian Ginger grass oil or Sophia variety of Rusha oil. Further work on the identification of its constituents is in progress in the Laboratory.

The Distillation of Stockholm-Tar.—A good deal of work has been done on the distillation of the "stockholm-tar" of commerce from the twisted chir (*Pinus longifolia*) wood of Kumaun. The tar as obtained by the closed-retort process in Kumaun has been shown to be of exactly the same composition as the imported stockholm-tar. The tar distilled by the dry-distillation of wood at the Forest Research Institute is slightly different from the "stockholm-tar" which is distilled in kilns in as much as it does not contain the excess of undecomposed rosin which is considered an essential ingredient of "stockholm-tar" for certain industrial purposes and is darker in colour than the latter. The kiln process is however not applicable to woods with low percentage of resin in them. Work is still in progress in order to ascertain some cheap way of distilling the wood on a large scale *in situ*, for the production of a suitable tar which is in great demand in Calcutta for the jute industry. The following table gives the comparative constants of the imported tar and that obtained by the closed retort method as experimentally adopted in the Kumaun Circle and the tar obtained by the dry distillation method at the Forest Research Institute :—

	I.	II.	III.	IV.
—	Stockholm tar made by the kiln process in Sweden.	Tar made by dry-distillation of wood, at Dehra.	Imported Stockholm tar sent by Messrs. Bathgate & Co., Calcutta, made by kiln process.	Chir tar received from Mr. F. Canning, Deputy Conservator of Forests, West Almora, by the closed retort process.
Colour	Brownish black.	Dark brown .	Deep brown .	Dark brown
Odour	Smoky	Smoky	Smoky	Smoky.
Consistency	Syrupy	Syrupy	Semi-solid	Semi-solid.
Solubility in 90 per cent. alcohol.	..	Completely miscible.	Completely miscible.	Completely miscible.
	Per cent.	Per cent.	Per cent.	Per cent.
Specific gravity	1·09	1·066	1·073	1·054
Pyroligneous acid	5	5·8	1·4	..
Light oil	3	29·2	30·6	18·93
Heavy oil or Creosote oil	30	31·1	44·4	46·15
Pitch	62	23·9	23·6	34·92
Hardness of Pitch	Less brittle	Brittle	Brittle	Brittle
Colour of Pitch	Black	Black	Black	Black.

TANNINS.

Galls of Pistacia integerrima.—These galls called *kakrasinghi* in vernacular, were known to contain as much as 75 per cent. of tannin. If the galls contained as much as 75 per cent. of tannin, or anything near as much, they would certainly be of incalculable value to the tanning industry representing actually a natural tan-extract. An enquiry was therefore instituted to see if these galls were at all so rich in tannin. The examination of authentic samples had shown that the galls contain only about 20-22 per cent. of tannin.

Leaves of Pistacia integerrima.—A sample of the leaves of this tree collected in winter gave 16 per cent. of tannin. It is possible that the leaves may be found to contain varying percentages of tannin at different periods of their growth and much more than 16 per cent. in a particular season.

The bark of Tsuga Brunoniana.—An average sample of the bark of *Tsuga Brunoniana* received from the Divisional Forest Officer, Darjeeling, was examined for tannin with the following results :—

	Per cent.	
Moisture	11·46	
Ash	1·28	
Total soluble solids	13·63	
Non-tannin	4·96	
Tannin	8·67	
Tannin calculated on dry material	9·71	
	Red.	Yellow.
Colour measurement taken in 1 c.m. cell	4·6	17·0

The bark is of some value as a tanning agent especially on account of its light colour. The percentage obtained is however too low to admit of its being profitably sent to any great distances for tanning purposes.

MISCELLANEOUS.

The Manufacture of Charcoal Briquettes.—An investigation in co-operation with the Forest Economist as to the best way of utilising the charcoal dust left in large quantities in the Forests and the Depôts was instituted at the instance of the United Provinces and the Punjab Forest Departments. It was proposed to make briquettes which should be strong enough to stand some amount of rough handling of the local trade. The enquiry was successfully completed during the year and fairly strong briquettes were made with 2·8 per cent. solution of the gum of *Bauhinia retusa*. Any gum giving a thick mucilage with water could be used for the purpose. The charcoal should first be reduced to a rough powder which is then just moistened with the gum-solution. It is then packed in a suitable mould and pressed into a briquette form by means of an hydraulic press. These briquettes were tested and found to burn well but much more slowly than the original charcoal used. It may be incidentally remarked here that light charcoals such as that of the chir pine which are at present almost valueless as fuel, would make a good fuel for many purposes in the briquette-form. Industrial experiments have to be continued to see if it would pay to have the entire quantity of the light charcoals reduced to rough powder and pressed into briquette-form.

The floss of Aerua javanica locally called "Bui."—A sample of the floss of *Aerva javanica* received from the Conservator of Forests, Marwar, was examined with the following results :—

	Per cent.
Moisture	11·2
Ash	11·6
Fat, resins, etc. (Ether solubles)	2·4
Sugar, starch, etc. (Water solubles)	14·6
Pectous bodies (1 per cent. of NaOH solubles)	18·6
Lignin	4·9
Cellulose (of very short fibre)	36·7

The wood of Butea frondosa.—A sample of the wood of *Butea frondosa* was received from the Conservator of Forests, Gwalior, to see if it could be used for pulp purposes. Its analysis for pulp gave the following results :—

	Per cent.
Moisture	10·62
Ash	1·90
Water extract, tannins, gums, mucilages	14·48
Resins and fats, etc.	1·04
Hydrolysis by treatment with 1 per cent. boiling NaOH	17·00
Cellulose	28·96
Lignin	26·00

From this it is evident that the wood loses a good deal in water and in hydrolysis and the percentage of cellulose is too low for remunerative reduction of this wood to pulp under ordinary conditions of collection, transport, and cost of reducing to pulp, etc.

Creosote oil made in India for sleeper treatment.—A further sample of the Indian Creosote oil was received and examined with the following results :—

	Per cent.
Specific gravity at 21°C	1·074
Loss at 100°C	4·55
Ether solubles	0·12
Free tarry acids	1·75

Fractions up to—	Percentage by weight.
200°C	5·05
200-240°C	7·31
240-260°C	17·90
260-280°C	17·20
280-300°C	13·00
300-320°C	15·40
Residue	24·14

From these figures, it is evident that the sample is of an excellent quality rich in anthracene fractions and is quite suitable for sleeper treatment. It is

indeed hopeful to see that some firms in India are beginning to see the necessity of distilling coaltar for its various products.

Soils.—The study of soil chemistry in collaboration with the Forest Botanist was continued.

A good deal of miscellaneous analytical work was done for the Forest Economist, Sylviculturist and the Forest Department in general. In fact the demand on the time of the Chemist was so great that he had no time to carry out some of the items of his own programme.

ASTRONOMY

BY

GILBERT T. WALKER, C.S.I., M.A., Sc.D., F.R.S.,
Director-General of Observatories.

Solar physics.—Researches in solar physics are carried on under the direct control of the Government of India at Kodaikanal, the Director being Mr. J. Evershed; the Assistant Director Dr. T. Royds has joined the Indian Army Officers Reserve. The chief instruments are :—

(*a*) A spectroheliograph made by the Cambridge Scientific Instrument Company, the object of which is to take photographs of the sun using the light emitted by one chemical element only. In this apparatus a stationary image of the sun is made by a 12-inch triple-achromatic lens of 20-foot focus, fed by an 18-inch Foucault siderostat. Close up to the image and somewhat longer than its diameter is the narrow vertical slit of a spectroscope arranged in such a manner that the light which has passed horizontally through the collimating lens shall be deflected through two right angles by two prisms and a mirror, and so shall emerge from the camera lens parallel to its original direction. This light then falls upon another vertical slit which can be adjusted in such a position as to allow light of any desired wave length to pass through. In the Kodaikanal spectroheliograph the collimating and camera lenses each of 5-inch aperture and 6-foot focal length, together with the prisms and slits, are attached to a rigid framework, while immediately in contact with the slit last described is a sationary photographic plate within a fixed camera. The rigid framework is capable of motion in a horizontal plane in such a manner that the primary slit may pass uniformly across the image of the sun while the secondary slit will move at an equal rate across the sensitised plate; and as in each position an image will be formed at the second slit by light of the desired wave length and no other light can emerge, the result of the movement upon the plate is a complete image of the sun in monochromatic light. At present the H and K lines of calcium are largely used on account of the convenience afforded by the width of their absorption shading and the fact that the centre of the dark line is frequently "reversed," *i.e.*, is bright instead of dark indicating that the calcium vapour is abnormally hot in the higher levels of the solar envelope. A photograph so obtained shows bright clouds—

called "flocculi"—of calcium vapour scattered about over the sun, and gives a large amount of information that is not otherwise obtainable. Further, by causing the slits to move more slowly the exposure may be lengthened sufficiently to give photographs of the "prominences" projecting from the sun's margin.

(*b*) An autocollimating spectroheliograph built in the observatory workshop. This is attached to the side of the Cambridge instrument and shares in the very perfect transverse movement of the latter. It is designed for photographing the sun's disk in the hydrogen line C. A large grating is used to obtain the highly dispersed spectrum which is necessary in photographing with this line.

(*c*) A high dispersion spectrograph mounted on piers in the spectroheliograph room. This is fitted with special arrangements for rotating the sun's image on the slit plate, and for accurate guiding during long exposures on sunspots or prominences. A special device has also been added for photographing simultaneously the spectrum of an electric arc on either side of a solar spectrum. A grating by Anderson with 5-inch ruling is usually employed.

(*d*) The 18-inch parabolic mirror referred to in the last report has been removed, and a 15-inch achromatic lens, borrowed from the Nizamiah Observatory, is now mounted on a moving carriage near the siderostat mirror. It is used mainly for sunspot spectrum work, and for photographing the spectrum of Venus.

(*e*) The new spectroheliograph erected at Srinagar in 1915 was dismantled in October 1916, and the optical parts returned to Kodaikanal.

(*f*) A 6-inch equatorial refractor with large grating spectroscope attached is used for the study of sunspot and prominence spectra, and for recording the prominences by visual methods. The equatorial mounting and the spectroscope are from the Maharajah Takhtasinji Observatory, Poona.

(*g*) The Poona 6-inch photo-visual lens was used in Kashmir for direct solar photographs on a large scale. It has been remounted at Kodaikanal, and the daily series of solar photographs on a scale of 8 inches to the diameter was resumed in February 1917.

Routine Work.—Daily spectroheliographic records of the sun are obtained at Kodaikanal in calcium and hydrogen light, whilst similar records have been obtained in Kashmir until October 1916, when the temporary observatory there was taken down. The routine work at Kodaikanal includes also visual examination of sunspots and faculæ, sunspot spectra, and bright lines or displaced lines in spots and prominences. A monthly article describ-

ing the solar activity is contributed to the "Monthly Weather Review," while for more technical purposes bulletins and memoirs of the observatory are issued. Of the former 56 have appeared, and of the latter two have been published.

Solar Work in Kashmir.—At Srinagar the conditions for solar work were found to be extremely favourable throughout the summer and autumn months ; but the winter and spring months were much less satisfactory, owing to cloud and poor definition at midday. The months November to May were nevertheless considered to be less unfavourable than the monsoon months (June-November) at Kodaikanal.

A valuable series of records of prominences and other solar phenomena was secured at Srinagar, the most notable being an eruptive prominence photographed on May 26th, 1916. A very complete series of photographs of this was obtained both at Srinagar and at Kodaikanal, and for the first time in our records it has been possible to trace out the movements taking place in the prominence from the beginning of the outbrust until the final phase, when the flying fragments attained the unprecedented height of 500,000 miles above the sun's surface. A description of this prominence was published in K. O. bulletin No. 55.

Spectroscopic Investigations.—A preliminary series of solar rotation spectrum plates was obtained at Srinagar. These are in the red region of the spectrum, and include the hydrogen line α. They have been measured by the positive on negative method, and the results prove the great value of this method for determining the solar rotation speed, as well as the relative movement of the hydrogen stratum and the reversing layer. It is found that systematic errors affecting ordinary methods of measurement are almost entirely eliminated, and by confining attention to a few strong lines a series of measures would easily settle the question of the supposed variability of the solar rotation. It has unfortunately not been possible to continue this research at Kodaikanal, owing to the prevalence of diffusive skies during the dry season of 1916-17.

The researches on the displacements of the lines in the solar spectrum compared with lines given by the electric arc have shown that there is displacement to red over the entire disc of the sun. This is least at the centre, and greatest at the limb, and as it is very difficult to interpret except by assuming a repulsion of the solar gases by the Earth, it becomes of importance to know whether this displacement affects only that side of the sun facing towards the Earth. To throw light on this question, high dispersion spectra have been secured of the planet Venus, when reflecting the integrated light of a solar hemisphere turned more than 90° from the direction of the Earth. The wave-lengths of the lines in the Venus spectrum have been determined by comparison with lines of the nickel-iron arc photographed simultaneously, due allowance being made for the effect of the planet's movements relative to Earth and Sun.

The measures appear to show a difference of wave-length in the lines as reflected by Venus and the same lines in direct sunlight ; but further research has revealed a slight instability of the lines in the electric arc when the positive and negative pole are composed of different metals. The above result, therefore, awaits confirmation by a new series of measures when it is again possible to photograph the spectrum of Venus.

Owing to the high degree of accuracy demanded in the measurement of spectrum lines, and especially the necessity of avoiding systematic errors, it is considered of great value to obtain estimates of displacements by independent methods ; and with this end in view Dr. Royds has designed and constructed an étalon. With this instrument, the measurement of interference fringes takes the place of measures of spectrum lines, and with nearly homogeneous radiations a very high order of accuracy is attainable.

METEOROLOGY

BY

GILBERT T. WALKER, C.S.I., M.A., Sc.D., F.R.S.,

Director-General of Observatories.

Upper Air Examination.—Work with pilot balloons was continued throughout 1916-17 at the same stations as previously, namely Agra, Simla, Kojak and Bangalore. The results were treated as before, and for the series of years now available at each place most of the figures of half-monthly and monthly vector resultants have been plotted to show the resultant trajectories of the period. The variation of corresponding periods from year to year are thus recognizable, for association with the variations in weather.

2. The series of balloons carrying recording instruments was continued at Agra.

3. Publication of observations and results is deferred in accordance with the general policy of Government in war time.

4. A year's series of air temperature observations under the normal Indian thatched thermometer shed and with two other methods of exposure, namely under a tiled shed and in a Stevenson Screen, was completed. The object was to ascertain what differences in results, if any, would be involved by the adoption of the less inflammable shed for general use in India, and to estimate the divergence of temperature between the standard Stevenson Screen exposure of thermometers at fourth class stations in India and that in the standard thatched shed of other Indian stations. Examination of the results shows appreciable divergences, and has raised questions which need further observations to answer. A second year's observations have therefore been started with certain modifications and additions. These include the use of a third shed, tiled and lined with wood, and the use of a motor-ventilated open-air exposure of maximum and minimum thermometers, shielded from external radiation in Assmann jacket tubes.

TERRESTRIAL MAGNETISM

BY

GILBERT T. WALKER, C.S.I., M.A., Sc.D., F.R.S.,

Director-General of Observatories.

Magnetic observatories.—Bombay (Alibag).—The Bombay Observatory, formerly maintained by the Local Government at Colaba, was moved to Alibag in consequence of the introduction of electric trams into the city. It is now directly under the Government of India, the Director being Dr. N. A. F. Moos. For a description of the instruments and of the routine work reference should be made to the annual Report of the Director. During the year material progress has been made with the preparation of the magnetic and seismographic data for press.

Magnetic Survey.—No. 18 Party—Magnetic.—The magnetic observatories at Dehra Dun and Toungoo were inspected by the officer in charge during the field season and a complete set of observations was taken at each for the comparison of instruments. The Alibag and Kodaikanal Observatories, under the Meteorological Department, were also visited for the same purpose.

No field observations were taken during the year, and none will be necessary until 1919-20 when it is proposed to visit all repeat stations to obtain data for the determination of reliable secular change values for the period 1914 to 1920.

Reports on the condition of the pillars of all the permanently marked repeat stations in India and Burma are being received yearly from the District Officials and it is satisfactory to note that the pillars are all in good preservation.

Reduction of observations to epoch.—The reduction of the magnetic elements of all the field and repeat stations in India, Burma and Ceylon to the epoch 1909.0 was continued during the year and is nearing completion. The Declination and Horizontal Force data are ready for publication but as the reduction of the Dip is well advanced it is now considered desirable to await the completion of the latter and to publish all the magnetic elements of the field and repeat stations together. With the published values of these elements will be included the average annual change of each element at the field and repeat stations for each of the two periods 1901 to 1909.0 and 1909.0 to 1914. There will also be issued the monthly mean values of the elements at the observatories and a set of isomagnetic charts, as well as a set of charts showing graphically the monthly mean values and annual change of each element at the observatories from 1901 to 1909.0 and 1909.0 to 1914, *i.e.*, the

average annual change will be given separately for each of the periods preceding and following the beginning of January 1909, the selected epoch of the survey, which is the date nearest to the point where an appreciable change is indicated in the curve of secular variation : the sections of the curve, or its division into the two periods 1901 to 1909.0 and 1909.0 to 1914 will each give a curve which will be approximately a straight line and will represent as nearly as possible a uniform or average annual change.

The magnetic elements at observatories.—The computation and tabulation of the provisional values of Declination, Dip, Horizontal Force and Vertical Force for the three observatories (Dehra Dun, Toungoo and Kodaikanal) for 1916 have been completed ; the mean values of these elements for the year 1916 derived from all days, excluding those of great disturbance, are given in the table below.

Observatory.	Latitude and Longitude.	Dip.	Declination.	H.F.	V.F.
	° ′ ″	° ′	° ′	C.G.S.	C.G.S.
Dehra Dun	30 19 19 N 78 3 19 E	N. 44 37·9	E. 2 11·0	·33050	·32627
Toungoo	18 55 45 N 96 27 3 E	N. 23 8·5	W. 0 8·4	·39018	·16676
Kodaikanal	10 13 50 N 77 27 46 E	N. 4 22·4	W. 1 27·9	·37633	·02878

GEOLOGY

BY

H. H. HAYDEN, C.I.E., F.R.S., D.Sc., F.G.S.,

Director, Geological Survey of India.

Mineralogy.—Several minerals of the rare earths, received from the Travancore State Geologist, were examined during the year. They included :—

(1) a tantalo-niobate and silicate of uranyl, iron and the rare earths, either hatchettolite or endeiolite ;

(2) a titano-niobate of uranyl and the rare earths—probably euxenite ; and

(3) a perfect crystal of thorianite ; this was found to contain 32·27 per cent. of ThO_2 and 39·86 per cent. of U_3O_8, with 2·92 per cent. of oxides of the rare earths.

Palæontology.—Palæontological research carried out by, and on behalf of, the Geological Survey of India, included :—

(1) a systematic examination and description of Lower Tertiary molluscs from Sind, Baluchistan and Burma ;

(2) a revision of parts of the Gondwana flora ; and

(3) examination and description of Palæozoic fossils from Chitral, the Russian Pamirs and Yunnan.

The first of these researches was carried out in India, and the remainder in England.

Geological Surveys.—Owing to the short-handed state of the Geological Survey Department, and also to the urgent necessity for investigations in connection with minerals employed in the manufacture of munitions, work on the systematic survey of the country was largely suspended. Reduced parties worked in Bombay, Rajputana, Burma, the Central Provinces and the Nizam's Dominions. In Bombay the survey of Idar State was completed ; in Rajputana, progress was made with the survey of the Ajmer and Beawar tahsils of Ajmer-Merwara, while in Western Rajputana, the unsurveyed portion of the Jaisalmer State was mapped.

The Burma party was engaged chiefly in economic work in connection with the output of wolfram in Tavoy, but a considerable amount of mapping was done, and the geological map of the greater part of the Tavoy district has been completed. It is now proposed to extend southwards into Mergui, and northwards into Amherst, although the absence of topographical maps renders systematic work in the latter district impossible.

In the Central Provinces, the geological survey of the Makrai State was carried out on the scale of 1″ = 1 mile, and certain unmapped areas in Balaghat and Bhandara districts were surveyed.

A long strip of country in the south-eastern part of the Nizam's Dominions, which had long remained blank on the geological map, was surveyed on the scale of 1″ = 4 miles.

Economic Enquiries.—These dealt with the following minerals: antimony in Mergui, chromite in Baluchistan, coal in the Bokaro-Ramgarh coalfield, molybdenite in Madura district, monazite in Mergui, potash salts and sulphur in the Salt Range, and ores of tungsten in Lower Burma. The energetic measures taken by the Government of Burma, with the assistance of the Geological Survey party, resulted in a large increase in the output of wolfram.

Investigations were also made with regard to proposed sites for dams at the Chichali pass, Mianwali district, and at Bhakra, on the Sutlej, in the Una Dun.

Meteorites.—Three new meteorite falls were recorded in India during the year; the first in Budaun district, Rohilkhand, the second in Ballia district, United Provinces, and the third in Birbhum district, Bengal. All three were chondrites.

GEODESY

BY

COLONEL G. P. LENOX-CONYNGHAM, R.E.,

Superintendent of the Trigonometrical Survey.

TRIANGULATION.

Triangulation operations during the cold weather of 1916-17 were carried out in the Madras and Bombay Presidencies principally to meet the requirements of the current topographical programme.

Madras.

The Madura Series.

This series was reconnoitred and the stations were built in season 1911-12. It extends from a side of the South East Coast Series near Arantangi in the south-west corner of the Tanjore District, through parts of the Tanjore District, Pudukkottai State, Ramnad and Madura Districts ; and closes on a side of the Great Arc Series near Dindigul. The observations were not taken up earlier as the country at the eastern end of the series is gently undulating and covered with groves of palm and other trees which render clear views impossible. The use of a trestle for the theodolite and of high masts for signals was necessary to surmount the curvature and the intervening trees. A trestle, by means of which the theodolite could be raised to an extreme height of 67 feet above ground level, and four masts each 100 feet high, previously devised by Mr. J. de Graaff Hunter, and constructed at the workshops of the Trigonometrical Survey at Dehra Dun, were used to secure the observations at the four western stations. The trestle observations were undertaken by Mr. Hunter and in spite of unfavourable weather conditions the triangular error averaged 3″ in three triangles.

Mr. L. Williams completed the series and on computation the series was found to exhibit the following satisfactorily small closing errors :—

Latitude	+ 0″·01
Longitude	—0″·09
Side, the unit being the seventh place of decimals	—205
Azimuth	+3″·2

Both observers used 8-inch micrometer theodolites.

The length of the circuit involved is about 280 miles.

Bombay and Hyderabad.

The Bagalkot Series.

While the observations of the Madura Series were being carried out, an assistant was deputed to reconnoitre and build a new series called the Bagalkot Series. This series, which forms a connexion between the Mangalore Meridional Series and the Naldrug Series, extends along the 16° parallel of latitude traversing parts of the Belgaum District, Southern Maratha Country States, Bijapur District and the Gulbarga Division of Hyderabad State.

The observations were carried out by Mr. L. Williams with an 8-inch micrometer theodolite and the accuracy of the work and the final connexion proved entirely satisfactory. The actual closing errors are :—

Latitude	—0″·06
Longitude	—0″·09
Side, the unit being the seventh place of decimals	—68
Azimuth	—1″·13

The length of the circuit involved is about 500 miles.

Punjab.

A detachment was employed on the laying out of Series of secondary triangulation in the Sind-Sagar Doab for the control of the "rectangulation" of that area in connexion with the great Indus-Jhelum-Chenab Irrigation scheme.

The work accomplished comprised the building of 51 new stations and the repair of 6 of the old Tower Stations of the Great Indus Series.

These stations form two chains of triangles, the one running from Khushab on the Jhelum to Leiah near the Indus, and the other running from about the middle of that chain in a north-westerly direction to Mianwali.

Astronomical work.

In June 1917 the reduction of the observations for latitude carried out in season 1907-08 at Robat S. of the Kalat Longitudinal Series, which had not been hitherto computed, was taken up. The observations were made on the circum-meridian plan, the zenith distances of the stars being taken with Troughton and Simms' 12-inch Theodolite No. II.

A large number of stars was observed and 117 separate deductions of the latitude were computed. The results proved very good, the probable error of the general mean being ± 0″·142 and that of a single observation ± 2″·18.

The values as derived from the astronomical observations and the triangulation are given below :—

	°	′	″
By Observation	29	49	09·16
By Triangulation	29	48	58·75
Astronomical—Geodetic A—G		+	10·41

The result shows a southerly deflection of 10·41 seconds.

LEVELLING OPERATIONS.

During the year 1916-17 the following lines of precise levelling were run :—

(a) In Bengal.

(*i*) Revisionary levelling from Chāmpdāni to Burdwān along the Grand Trunk Road, originally levelled in 1882-83.

(*ii*) From Burdwān to Barākar. This completes the new line of levels along the Grand Trunk Road from Benares to Barākar.

(*iii*) From the Dāmodar river to Barākar along the main road from Purūlia. This is part of the new line brought down from Aurangābād *viâ* Daltonganj, Rānchī and Purūlia to Barākar.

(b) In Bihār and Orissa.

(*i*) From Aurangābād *viâ* Daltonganj, Rānchī and Purūlia to the Dāmodar river along the main roads. This line was carried on to Barākar in the Bengal Presidency.

(*ii*) From Barhī *viâ* Hazāribāgh to Rānchī along the Public Works Department road.

The above lines complete two new circuits, the closing errors of which have not as yet been determined as the computations are not complete.

The total outturn of levelling including branch-lines amounted to 540 miles.

TIDAL OPERATIONS.

During the past year tidal registrations by means of automatic gauges have been continued at the following stations :—

Aden, Karāchi, Apollo Bandar (Bombay), Prince's Dock (Bombay), Madras, Kidderpore, Rangoon, Moulmein and Port Blair.

The tide-gauges at the above stations have, on the whole, worked satisfactorily ; there have been no serious interruptions in the registrations anywhere.

All the tidal observatories were inspected during the year and the instruments were thoroughly overhauled, cleaned and put in working order.

Owing to constant silting at the Kidderpore tidal observatory and the difficulty of maintaining free communication between the river and the observatory well, it was decided by the Port authorities to construct a new observatory in deeper water about 30 feet away from the old one. The new observatory was ready in April 1917 and the tide gauge was then installed in it. The old observatory has been abandoned.

In addition to the automatic tidal registrations at the 9 stations named above, observations of high and low water on tide-poles were taken during day-light at Bhaunagar, Chittagong, and Akyab, with the object of testing the accuracy of the predictions which were based on tidal registrations taken at those ports many years ago.

From March 1916, the Chief of the General Staff in Mesopotamia has supplied this office with hourly readings of a tide-gauge at Basrah which was erected there in connection with the Military requirements. With the object of making predictions of the tides for Basrah, the above readings for a whole year have been reduced in this office by means of harmonic analysis and the constants thus deduced have been forwarded to the National Physical Laboratory, Teddington, England, in order that the tidal curves for the year 1917-18 may be traced by the tide-predicting machine, which is lodged at the above laboratory, and supplied to this office. On receipt of the curves the times and heights of high and low water will be read from them and supplied to the Inland Water Transport authorities at Basrah.

OPERATIONS AT DEHRA DUN

BY

J. de GRAAFF HUNTER, M.A.

The provisional adjustment of the Burma triangulation has been practically completed. This has been done primarily with a view to making the publication of the results in consistent form possible.

Until the closing discrepancies of circuits are distributed the junction points have multiple values and cannot be conveniently used for general topographical purposes in relation to points on either side. The adjustment has been carried out by the new simplified method referred to in the report for 1914-15. In last year's report the desirability of the use of Laplace Stations as well as extra bases was referred to. This has received practical confirmation in the Burma Adjustment. In the adjustment, however, in conformity with previous practice, the Laplace stations were ignored and the adjusted values show increased discrepancies at the Laplace stations: indicating the necessity of adjusting the triangulation at such stations.

In the present work the main object has been to prepare the data in a suitable form for publication for general, and not specially for geodetic, use. This has been done. It will be desirable perhaps at some later date, for geodetic purposes, to make a new adjustment when the figure has been made more complete by the observation of the Chittagong Series and the closing of the Upper Irrawady Series, etc. Such adjustment should not however be done until the work is provided with well distributed bases and Laplace stations, without which little improvement in accuracy could be expected. In making this new adjustment it will not be necessary to correct any but the geodetic stations and the work involved will not be considerable.

During the year a list of all plumb line deflection stations of India and Burma has been compiled by degree sheets, and the results exhibited in terms of Everest's spheroid and also in terms of Helmert's spheroid. In the course of the work numerous points for decision have arisen, showing the need of a comprehensive treatment of the data. By means of this compilation it has been possible to construct sections of the geoid, and it appears that a southerly deflection of some 5″ probably exists at Kalianpur. It is interesting to note that if this deflection be allowed for the Indian results are brought into agreement with the Russian results in Turkestan. The list of deflections is being published in the first place in Professional Paper 16, the completion of which has been retarded by press of other work. In this paper will also be found a computation of the probable errors, after adjustment, of the North-West Quadrilateral.

BOTANY.

I.—BOTANICAL SURVEY

BY

H. G. CARTER, M.B., CH.B. (EDIN.),

Offg. Director, Botanical Survey of India.

Systematic.—*Eastern and Northern India.*—Apart from one or two minor expeditions, no exploration work was undertaken during the year and the staff have, therefore, been able to devote all their time to the collections of correspondents and accumulated materials awaiting examination. The same officers, as in former years, chiefly members of the Forest Department, have continued to keep us well supplied with material. Rai Upendranath Kanjilal Bahadur visited the Herbarium for several weeks in connection with his work on the Forest Flora of Assam. A considerable mass of his material still awaits examination but we have benefited as formerly by his generosity in giving us many sheets which enhance the value of our collections. Mr. R. S. Hole of Dehra Dun and Dr. C. A. Barber of Coimbatore have also visited the Herbarium in connection with research work in hand. The usual collections of high level seeds for distribution to temperate regions were made by Mr. G. H. Cave who also continues work on his materials for the Lloyd Botanic Garden Catalogue. The results of the examination of Mr. R. E. Cooper's tours in Bhutan are now to some extent to hand in the publication by Professor Bayley Balfour of new species of Primula and Rhododendron. The revision of the Himalayan and Chinese Primulas already in collections, together with Mr. Cooper's new material, has given some forty new species. Of these, fifteen are the result of more critical examination in the light of recently acquired knowledge from the East and West Himalaya ; eight are Bhutanese, the outcome of Mr. Cooper's exploration, and the remainder are Western Chinese. From the same collector's material Professor Balfour has been able to record two new Bhutanese Rhododendrons and four others of the same genus come in Mr. Ward's material from East Upper Burma. Mr. I. H. Burkill, late of the Botanical Survey, has two papers in the Journal of the Asiatic Society of Bengal. One deals with the pollination of flowers in India, the other with the Terai forests between the Ghandak and the Teesta. The results of Mr. C. C. Lacaita's tour, some two or three years ago, in Sikkim, have been published in the Journal of the Linnean Society where the author records his impressions of the forests of Sikkim with some historical data on earlier exploration of the same region and a list of plants seen or collected.

Mr. A. Rodger, Forest Research Officer, Burma, has again materially enriched the local Burmese collections of the Botanical Survey and retentions from collections by Messrs. Smales, Osmaston, and by Lady Cuffe have also been allowed.

The Flora of Siam and Eastern Burma continues to engage the attention of Mr. W. G. Craib. During the year some eighteen species, not previously represented in his materials for a flora of this area, have been described in the Kew Bulletin.

Western India.—The results of Messrs. Sedgwick and Saxton's work on the vegetation of Northern Gujarat, referred to in last year's report, are still in the Press. The late Mr. Ramaswami's record and description of a new *Tephrosia* from Sind appeared during the year. Mr. H. M. Chibber's list of families and genera of Bombay plants with derivatives continues to appear in the Journal of the Bombay Natural History Society. Mr. C. C. Calder has had under examination several species of *Cassia* from this Society's garden in Bombay and has established a good connecting link between two hitherto supposed distinct plants. His observations point to the advisability of a re-examination of the characters hitherto separating some members of the genus.

Southern India.—This area continues to attract more botanical attention than most of the other provinces. Mr. J. S. Gamble, C.I.E., continues his work on the Flora of the Presidency but, owing to the loss of Mr. Dunn's co-operation, the whole work devolving on Mr. Gamble's own hands, the issues must in consequence be somewhat delayed. The method of presentation adopted is that followed in the corresponding work for Bengal, issued in 1903. The primary object is to facilitate the identification of the species by enabling the collector to ascertain with certainty the genus to which the plant belongs and, this object attained, to limit his attention to those characters of the plant under examination which are necessary to its specific identification.

Mr. P. F. Fyson communicated two papers to the fourth sessions of the Indian Science Congress held at Bangalore in January 1917, one dealing with œcological observations on the flora of the Pulney Duars, the other with observations on the struggle for habitat between a true water plant (*Scirpus mucronatus* Linn.) and a moist land plant (*Ammannia rotundifolia* Ham.).

Mr. C. E. C. Fischer has under preparation for publication in the Records a paper on the Flora of the Anamalais.

Rai Bahadur K. Rangachari presided at the Botanical Section of the Indian Science Congress where he communicated a very interesting paper on the Tinnevelly Flora.

On the same occasion Mr. Venkata Rao and Mr. Cherian Jacob gave papers on the distribution of plants in Mysore, and on pollination in *Alysicarpus*, respectively, while Mr. T. Ekambaram gave the results of his continued investigations on the structure and mechanism of the bladders of *Utricularia*.

The proximity of Ceylon and the great similarity of its vegetation to that of the southern extremity of the peninsula lends additional interest to Mr. J. C. Willis' paper on the evolution of the flora of the island with reference to the dying out of species.

General.—The Revd. Father Blatter's treatise on the palms of British India, indigenous and introduced, deals, since last report was issued, with groups *Cocoineae* and *Lepidocaryinae.* In all some nineteen species are dealt with, the history, nomenclature, taxonomy and uses being treated in an exhaustive manner. Major A. T. Gage continues, so far as the very limited time at his disposal will admit, preparation of his materials for monographing the family *Euphorbiaceæ.*

Dr. Stapf has given an historical and taxonomic account of *Cycas Thouarsii* R. Br. and contrasted its characters with those of *Cycas Rumphii* Miq. and *Cycas circinalis* Linn., and has also had *Pandanus percatus* described and figured in the Botanical Magazine. Mr. Dalimore has contributed an account of the Asiatic Pines, including some Indian representatives, to the Kew Bulletin. Mr. H. G. Carter's paper on Zor Hills Plants with Notes by Sir Percy Z. Cox, K.C.S.I., K.C.I.E., has been issued as Volume VI, No. 6 of the Records of the Botanical Survey while Mr. Calder's records of the species of *Oxalis* now wild in India is ready for the Press and his account of the vegetation of Travancore is nearly completed.

BOTANY.

II.—ECONOMIC BOTANY.

Part I.—Agricultural Botany

BY

ALBERT HOWARD, C.I.E., M.A. (CANTAB.), F.L.S.

Imperial Economic Botanist.

In previous reports, attempts have been made briefly to summarize all the various lines of work dealing not only with the improvement of crops in India but also with the progress made in seed distribution. Till recently, this was the only method of bringing to the notice of the public the work of the Agricultural Department on the application of Botanical Science to Agriculture. At the present time, however, another means is in existence for accomplishing the same purpose, namely, the annual *Report on the Progress of Agriculture in India*. In this publication, the last issue of which extends to 130 pages of print, is to be found full details of the various lines of work on crops in India together with an account of the present position of seed distribution. At the end of the report is printed a classified list of publications, dealing with the various branches of agriculture. As this progress report is prepared after the various Administration Reports of the Provincial Departments of Agriculture are issued and after most of the annual farm reports appear, it is obvious that it can be made more complete than the present summary which has to be submitted before these various publications are available. In the present report therefore, detailed references to seed distribution schemes have been omitted and only the more purely scientific papers dealing with Economic Botany have been noticed. In this way, it is hoped to avoid undue overlapping with the Progress Report on Indian Agriculture. As most of the work which has been published during the year ending June 30th, 1917, was dealt with in advance in considerable detail in the previous report, but little remains to be done to bring the subject up to date.

In addition to the list of technical publications appended to this paper, the following reports contain a considerable amount of information on the improvement of crops. A perusal of these papers will enable the student of Indian agriculture to obtain the fullest possible details of what is now being done.

(*a*) *Report on the Progress of Agriculture in India.* This is an annual report prepared by the Agricultural Adviser to the Government of India, Pusa, Bihar, from whom copies can be obtained.

(*b*) *Annual Report of the Agricultural Research Institute, Pusa* (including the report of the Imperial Cotton Specialist). Copies are to be obtained from the Director, Agricultural Research Institute, Pusa, Bihar.

(*c*) *Administration reports of the Provincial Departments of Agriculture*—Bombay, Bengal, Madras, Central Provinces, United Provinces, Punjab, Bihar and Orissa, Assam and Burma. These are issued towards the end of the year by the Government presses in these Provinces and contain a general summary of the work of the Agricultural Department (including the farm reports) and also summaries of the work of the various specialists including the Economic Botanists.

(*d*) *Proceedings of the Board of Agriculture in India.* This contains the programmes of work in progress in Economic Botany. Copies can be obtained from the Agricultural Adviser to the Government of India, Pusa, Bihar.

Cotton. Little of a strictly botanical nature has been published on this crop during the year owing to the time of the research officers being taken up with other duties and to shortage of staff. The large amount of work in progress on seed distribution in cotton will be dealt with as usual in the next Progress Report on Agriculture in India.

The position as regards the cotton breeding work at Cawnpore will be clear from the following extract from Mr. Leake's current annual report :—" Work on cotton has again been practically limited to preventing loss of material and to the extension of the type K 22. Of the two types mentioned last year, K 7 and K 22, the latter is undoubtedly superior and the former type is being dropped. Particulars of the results achieved with the latter await a more favourable opportunity for publication but I may note that the cotton problem of the United Provinces, as it appears to me, may be briefly summed up as the production of a high ginning and high yielding race of cotton with a lint quality which would normally find a market in India but which, in times of shortage, would find a market in Lancashire. How far K 22 satisfies this definition is shown by the following. I have now a considerable acreage under races ginning 40 per cent.; though perhaps not so resistant to moist conditions, in a good cotton year it yields as much *kapas* as the Aligarh white flowered ; while as regards lint, the following remarks from a broker at home will show how far it fulfills the requirements given above. ' The sample of cotton you sent is certainly usable by a considerable number of Lancashire Spinners provided they could not get anything better, they being very conservative. I fully agree with you that after the war we shall be very short of cotton with a big demand, in fact we are fast reaching a famine in Liverpool with cotton 17*d*. per lb.' I may refer here to the extension of cultivation of the plant into Central India. Trials made last year were sufficiently promising to justify Mr. Coventry distributing the seed I could provide,

That quality of the lint vastly improves under Malwa conditions is shown by the fact that samples are valued as nearly equal to best Ujjain."

In the Central Provinces, apart from the work on seed distribution, a most interesting discovery has been made by Mr. Clouston with regard to the requirements of the roots of the cotton plant. "Experiments carried out with Cambodia and Roseum cotton on the laterite soil in Chhattishgarh, known as *bhata*, have shown that on very pervious soil of this type, where drainage and root aeration are perfect, very good crops of cotton can be raised though the rainfall is over 50 inches. It is a commonly accepted opinion in this part of India that cotton cannot be grown successully with a rainfall exceeding 45 inches. Drainage and aeration would appear to be all important in the production of good yields of cotton; so long as these are favourable, the heavy rainfall does not really matter much." The writer was fortunate enough to see last January the Chandkhuri experiments referred to in the above extract of a note from Mr. Clouston. Besides their local interest, these results indicate a new field of work on the cotton crop in India, namely, the investigation of methods of improving the yield by some system of under-drainage combined with the improved aeration of the subsoil. In wet seasons like 1916, the cotton crop never does well either on the black soils of the Peninsula or on the alluvium. Vegetative growth becomes unhealthy and the production of mature bolls is far below the normal. All the appearances indicate defective soil aeration. These facts, taken together with the Chandkhuri results on the porous *bhata* soils, leave little doubt that the cotton crop would at once respond to some form of sub-soil drainage. Not only would this improve the yield but it would also, in all probability, at once open the door to the successful cultivation of deep-rooted, long stapled varieties. At present, the Indian cotton crop is at the mercy of the monsoon and there are indications, both in the plains and on the black soils, that the varieties which thrive are comparatively surface-rooted. In a dry year, they are liable to suffer from drought, in a wet year, the crop is water-logged. Subsoil drainage and sub-soil aeration, by increasing the root range, might help to render the cotton plant independent of the rainfall. Under the new soil conditions, long-stapled cottons might easily do much better than is now the case.

In Madras, Mr. Hilson has published a note on a method of selfing cotton which deserves a full trial in other parts of India. As the publication, in which it appears, is a new one and may not reach all workers on this crop, it is reprinted here in full. "The following method of selfing cotton plants, since it has proved both simple and efficient has been adopted in dealing with the black soil varieties of the Ceded Districts and Cambodia at Coimbatore. The flower is prevented from opening by sewing up the bud in the early morning of the day on which it would open or in the evening of the previous day. The needle is passed through the bud about three times at a point, about a quarter of an inch from the top, where the petals are tightly rolled together. The thread is pulled as tight as possible without cutting the petals. The needle

is then passed several times through one of the bracts, leaving about two inches of loose thread between the tip of the bud and the bract. In this way, the flower remains tightly closed and cross-fertilization by insects or wind agency is prevented. After setting, the corolla withers and falls off, when it is suspended by the thread and efficiently labels the boll. It is impossible to fake this effect, thus any intelligent coolie may be employed for the work with perfect safety. After a little practice, the operation can be performed very quickly and one man can self all the flowers, as they appear, of a considerable number of plants. The setting of flowers treated in the above manner is perfectly normal and there appears to be less shedding of flowers and young bolls than is the case when paper or muslin bags are employed."

Rice. Continued attention is being paid to the improvement of the rice crop. Most of the work relates to pure line selection with the object of isolating types of high yielding power. At a few centres, investigations on the inheritance of characters in the crop are also in progress. These two lines of work will be considered separately.

Pure line selection is in progress in all the chief rice growing Provinces of India. In Burma, work in this direction is being prosecuted in the Southern Circle by Mr. McKerral and at Mandalay by Mr. Thompstone. Three selected strains, derived from single plant cultures at the Hmawbi Agricultural Station, are now under distribution and nearly 200 tons of seed of these were distributed during the last two years. In Madras, the chief centre of selection work is at Coimbatore. The stage reached in the work will be clear from the following extract from Mr. Parnell's last annual report :—" The testing of the yield of a number of strains and varieties was continued and two that had been the best the previous year were again ahead of all others. One of these gave a very heavy yield on an area of several acres on the Central Farm. It is a very distinct improvement on the local variety and is also a little earlier, a very useful quality on account of the uncertainty of the water supply towards the end of the season. Some very promising strains were obtained in the third generation of a cross between two varieties. They have not yet been tested on a large scale however. Definite experiments were carried out to decide on the most satisfactory method of comparing strains for yield. It was found that long narrow strips 5 by 120 links that is 0·6 cent. in area, gave a probable error of less than 6 per cent. for the difference between two. This is about half the probable error given by 5—10 cent. plots in ordinary farm experiments. The repetition of these strips, four times, reduces the error to less than 3 per cent. and this system has been adopted on the paddy Breeding Station. Work on the Paddy Survey was continued and a number of new varieties were grown and described during the year." In Bengal, Mr. Hector has brought his preliminary work on selection to a satisfactory conclusion and an improved variety known as *Indrasail* has emerged from the tests. Several hundred maunds of seed of this variety were distributed to cultivators during the year. In the Central Provinces, selection work on rice is in pro-

gress at two centres—Raipur and Nagpur. Mr. Clouston sums up the Raipur work as follows :—" Over 100 varieties of paddy have been tested in varietal series on the Raipur Farm. All have been discarded except six, the outturns of which have, over a series of years, topped the list in the varietal series. These varieties are *gumratia*, *chinoor*, *parewa*, *haradgundi*, *bhondu* and *luchai*. Pure cultures of these are also being propagated and compared. Over half a million pounds of seed of selected *gurmatia* and *parewa* from pure strains have been distributed through seed farms this year. Twenty selections have been made from each of the six varieties mentioned above, of which the best ten of each are being tested in plots of one-tenth of an acre this year. One Assistant on each farm is put in charge of this special line of work as I am convinced that the improvement of crops by selection is largely the work of the Deputy Director of Agriculture and his staff." Mr. Graham reports that the extension of the two selected rices Nos. 12 and 17 in the Northern Circle is maintained.

A beginning has been made in the study of the inheritance of characters in rice at several centres. Mr. Hector published a Memoir on the inheritance of anthocyan pigment in paddy varieties and concludes :—(1) The colours in the leaf-sheaths, glume-apex and stigma of certain paddy varieties appear generally to be due to the interaction of several factors. (2) In certain cases, the colour in the stigma is of a higher order than the colour in the leaf-sheath and glume-apex, and is due to the presence of an extra factor not present in the leaf-sheath and glume-apex. (3) Where the colour has been found to be due to the interaction of more than one factor, the simultaneous presence of all colour factors appears necessary for the production of colour at all. At Coimbatore, Mr. Parnell's work referred to in the previous report has been continued. He reports that " some of the more definite characters such as duration, size and shape of grain, height of plant prove to be complicated and difficult of analysis." In Bombay, the Mendelian work on rice conducted by Dr. Burns is described in the Ganeskhind report for 1915-16.

Sugarcane. Although India, in comparison with Java and the West Indies, took up the study of cane seedlings comparatively recently, nevertheless a great deal of energy is now being devoted to this work at two centres — Coimbatore and Bangalore—and considerable progress has been made in this difficult and time-consuming undertaking. At the Cane-Breeding Station at Coimbatore, Dr. Barber and his assistants are taking up several lines of work simultaneously, namely, the detailed botanical study and classification of the varieties at present grown in India ; the production and testing of new seedling canes and the study of the conditions under which the sugarcane flowers and sets fertile seed. At Bangalore, Dr. Coleman is also devoting attention to the production of sugarcane seedlings. The object of the Bangalore work is to get a variety with high yielding capacity and rich glucose suitable for Mysore. Varietal tests conducted for a series of years have shown that Red Mauritius yields more than any of the local varieties but its juice is not so rich. Seedlings of this cane have been raised which promise to retain

the vigour of the parent while giving a richer juice. Seedlings of White Mauritius and of Striped Mauritius are also promising. A number of these will be tested on a field scale during the coming year. In addition to the work on seedlings, other varieties are also being tested of which Java 33a is likely to prove a useful cane for Mysore.

In the plains of India, where the sugar cane rarely forms fertile seed and where the difficulties connected with the raising of new seedlings have not yet been overcome, a different line of work has for some years been carried out at Shahjahanpur in the United Provinces by Mr. Clarke. This consists in the study (in the field and in the laboratory) of local and introduced canes which are likely to suit the short growing period of Northern India. The preliminary work in this direction has recently been brought to a successful conclusion, the main results of which are to be found in a paper in the *Agricultural Journal of India* of July last year. Two improved canes have emerged satisfactorily from these trials—Java 33 for ordinary field cultivation and Ashy Mauritius for intensive cultivation near the large cities.

Passing from the main lines of investigation on the improvement of the sugar cane in India to the details connected with this work, a considerable amount of new matter has been published and prepared for the press by Dr. Barber and his staff at Coimbatore. The nature and scope of these papers will be evident from the following extract from the last annual report of this Station :—

" During the past year, a Memoir (referred to as completed in last year's report) dealing with the characters of seedling canes and the work of the farm since its commencement has been issued from the press. With the rapid accumulation of observations, several new lines of work are opening up, all of which it is hoped will in time be dealt with as Memoirs of the Agricultural Department.

Casual observations as to the characters of two closely allied indigenous cane varieties of South India, *Naanal* and *Cheni*, reveal the fact that these two canes are advanced representatives of two great classes of canes scattered all over the Provinces of India, differing among themselves in size to such an extent that their relationship has not been obvious before. Thirty-three of these varieties growing on the farms have been brought together and somewhat exhaustively studied. As stated in a preliminary note, published in the *Agricultural Journal of India*, they are called the *Sunnabile* and *Saretha* classes and, with their accurate description, a large part of the less obvious classification of Indian canes has been rendered clear. The study of the general characters of these two classes has been completed and it is intended to summarize these in a Memoir which is nearing completion.

This work has entailed numerous measurements of the lengths of successive organs of the cane plant and it has transpired that these measurements may be plotted out in curves which have very definite characters for the different organs, for the different varieties and groups and even for the local-

ities in which they are grown. The results are so instructive as to the growth of different varieties in different places that it is proposed to collect and compare them and attempt to trace through them the effect of different conditions upon the growth of the cane plant. A very large number of measurements have now been made in various parts of India and it is proposed to present the results of this study in another Memoir.

A casual dissection of the underground parts of a few cane clumps has resulted in the discovery that the different classes of canes, from the wild *Saccharum spontaneum* to the thick tropical canes, while agreeing generally as to behaviour of each class, show a series of distinct stages in the classes, between these two extremes. The stools of about 20 varieties have been dissected and, these suggest that a definite formula can be evolved for each class of canes, which will throw light on its relative stage of development from the wild *Saccharum*. A further corroborative series of dissections is included in the year's work, which will complete the series. It is proposed to present this also in Memoir form.

Numerous observations have been made from the start, on the wild *Saccharums*, especially *Saccharum spontaneum* which is regarded as the wild form from which cultivated sugarcane has been derived. It has been demonstrated that at least three forms of this species occur, some of them much thicker than the common *kans* grass, and correspond to well defined geographical regions. Seedlings have been freely used in crossing with various thick and thin canes. If time permits, it is intended to collect the observations and dissections made of these and other wild species of *Saccharum* and publish them.

Two papers were read at the recent Indian Science Congress at Bangalore. (1) A study of the sucrose variations in successive cane joints by Messrs. T. S. Venkataraman and K. Krishnamurti Rao and (2) Arrowing in the sugarcane with special regard to selfing and crossing operations by the former. These two papers have been published in the special Congress Number of the *Agricultural Journal of India*. A paper has been compiled by Mr. K. Krishnamurti Rao on the effect of salinity on cane juice and contains a summary of all the observations made at the Cane Breeding Station on this point."

Wheat. Little of a scientific nature has been published during the year on this crop and there is practically nothing to add to the details in the previous report regarding the selection and breeding work in progress. Seed distribution, which has now become a very important item in the work of the Agricultural Department, will be dealt with in the next Progress Report on Agriculture. The only purely scientific paper published during the year was the botanical classification of the wheats of Baluchistan, Khorasan and the Kurram valley. In this Memoir, the results of a large amount of preliminary work has been recorded which will serve as an introduction to the improvement of the wheats of the upland frontier valleys. Attention is also drawn to the shortcomings in the existing methods of classification of wheat varieties.

Weeds. The rapid increase in the growth of the water hyacinth (*Eichornia crassipes*) in several localities in India and the probability of interference with navigation in the minor water-courses, have led to a certain amount of investigation of this plant. In Bengal, Messrs. Finlow and Maclean have conducted a number of investigations on the manurial value of the weed on the Dacca farm. The analytical figures indicate that rotted water hyacinth is about as rich as farm yard manure (of the same water content) in nitrogen, phosphoric acid and lime, but it contains several times as much potash. The Dacca experiments indicate that the plant will prove of use as manure, and there are said to be indications in the District that the cultivator is beginning to appreciate the agricultural possibilities of the water hyacinth. In Burma, it has been found necessary to legislate against this weed and the Burma Water Hyacinth Act, No. 1, 1917, has been passed in the Local Legislative Council.

Jute. The preliminary work connected with the botanical survey of the varieties of jute, commenced in 1906 by Messrs. Burkill and Finlow, has led to the isolation by Mr. Finlow of a type known as *Kakya-Bombai* which yields heavy crops of fibre of good quality. In the present season, 150 maunds of seed were sown sufficient for 1,500 acres of land. So far, no pure line has been found which combines, in the highest degree, the most desirable qualities which are possible, namely (*a*) high yielding power and (*b*) maximum strength and durability of fibre. It is hoped ultimately to obtain, by means of hybridization, what is required.

Indigo. During the year, an account of the present position of the indigo investigations at Pusa was published. The matter was gone into in considerable detail and the report contained chapters on the following—the principles underlying the production of natural indigo; indigo wilt; seed supply and the improvement of indigo. Selection work is in rapid progress and improved kinds are now being grown on several estates. A study of the working conditions disclosed the important fact that under Bihar conditions, the improvement of Java indigo by chemical selection is beset by numerous difficulties mainly of a botanical nature.

Fruit. Attention continues to be paid to the problems connected with fruit culture. Dr. Burns has continued his work at Ganeshkhind and has obtained interesting results in training the guava and in crossing various types of papaya. An exhaustive study of the inflorescence, flowers and fruit of the banana is nearing completion, the results of which have not yet been published. Among other papers on this subject may be mentioned one by Mr. Vagholkar on the propagation of *Zizyphus jujuba* in East Khandesh by ring budding.

Root nodules. An interesting paper on this subject by Mr. Gangulee has recently appeared in the *Poona Agricultural College Magazine.* The development of nodules on the roots of four plants was studied—*Dolichos Lablab, Cicer arietinum, Crotalaria juncea* and *Phaseolus Mungo* var. *radiatus.*

In these experiments, numerous nodules appeared on the gram roots five days after sowing, while on the other plants these did not appear till later.

Chillies. An account of the various types of chillies cultivated in the Central Provinces has been published by Mr. K. P. Shrivastava. Eleven types are described of which one is recommended for dry cultivation and two others where irrigation is possible.

Soil aeration. A considerable amount of attention is being paid at Pusa to the role of soil aeration in crop production in India. The general nature of the evidence in favour of the view that both yield and quality often depend on soil aeration is set out in detail in Bulletin 61 of the Pusa Institute. This publication has attracted a good deal of attention throughout the Empire and has helped to set on foot a large number of investigations. At Pusa, where collections of types of several crops are grown, it has been found that all the varieties which really do well under the local conditions are shallow-rooted while the deep-rooting kinds yield poorly and are often attacked by various diseases. This accords with the view that the Bihar alluvium acts as a vast oxygen filter separating the atmosphere from the soil water which is particularly poor in dissolved oxygen. Only the surface skin of the Bihar alluvium is made use of by crops. As soon as the effective root range is increased by surface drainage, the yield improves. Dilution of the soil with substances like potsherds which improve the aeration also increases the yield. Last year at Pusa, the addition of an inch of this material increased the yield of grain per acre considerably—in the case of oats the increment was 366 lb. per acre, in wheat 269 lb. per acre. The dependence of quality on soil aeration has been confirmed by Mr. Clouston's experiments on cotton, sugarcane and groundnuts at Chandkhuri near Raipur on the *bhata* soils of the Central Provinces. Further confirmatory evidence on the importance of soil aeration on growth both from the cultural and anatomical standpoints have been published by Mr. Hunter in Great Britain. As this work has a direct bearing on Indian agriculture, Mr. Hunter's papers have been added to the list at the end of this report.

BOTANY.

II.—ECONOMIC BOTANY.

Part II.—Forest Botany

BY

R. S. HOLE, F.C.H., F.L.S., F.E.S.,

Forest Botanist.

Soil-aeration.—In co-operation with the Chemical Adviser work was continued at Dehra Dun with the object of identifying the factor detrimental to root-growth which has been provisionally defined by the expression *bad soil-aeration*. As noted in previous reports, it is believed that this factor is, in many cases, primarily responsible for the failure of reproduction in our forests and for the root diseases of some of our most important species. It was found that if rain water, with an initial content per litre of one milligram of carbon dioxide and 7 milligrams of oxygen, was held in corked pots in contact with soil taken from a local SAL (*Shorea robusta*) forest, the carbon dioxide increased to 63 milligrams per litre in two days and 233 milligrams in 28 days. On the other hand, the oxygen content fell to one milligram per litre after two days and then apparently remained fairly constant. Sal seedlings growing in this soil which was thus kept saturated with rain water began to show, after 10-13 days, signs of root trouble, the leaves turning yellow and hanging vertically downwards, whereas the leaves of the control plants in aerated soil remained dark green and horizontally extended. After 31 days in badly aerated soil 94 per cent. of the seedlings had their roots more or less extensively decayed. An attempt was then made to test the effect of carbon dioxide on the roots of *Sal* seedlings by growing the latter in water cultures and bubbling the gas through the culture solutions. After 12 days, 100 per cent. of the seedlings in the injected solutions showed diseased roots whereas only 22 per cent. of the plants in the control solutions showed unsound roots. The concentration of carbon dioxide attained in the injected solutions (200 to 900 milligrams per litre), however, was considerably higher than that found in the soil solution in the badly aerated pots.

Further experiments will be undertaken with the object of testing in water cultures the same concentrations of carbon dioxide and oxygen as are actually found to exist in badly aerated soil.

It has been known for some time that a layer of dead leaves on the surface of the ground is inimical to the healthy development of *Sal* seedlings. *Sal*

seed and the young seedling in the first stages of germination are very liable to be killed by drought if they are exposed to sun and dry air and are not kept constantly moist. The injurious action of a layer of dead leaves, therefore, is in part purely mechanical, inasmuch as it keeps the seed out of contact with the soil and prevents the delicate radicle from rapidly penetrating the moist soil. In addition to this, however, a layer of decaying leaves on the surface of the soil interferes with soil-aeration and is thus detrimental to root development. An experiment was carried out to test this last point during the year. *Sal* seed was germinated in 4 pots filled with loam from a local *Sal* forest and when the seedlings were well established and had produced healthy green leaves a layer of dead *Sal* leaves, 6 leaves thick (which is approximately equal to the annual leaf-fall), was placed on the surface of two of the pots containing 26 healthy plants, the remaining two pots containing 24 seedlings being kept as controls. In four weeks, the foliage had turned brown on 6 of the plants in the pots with dead leaves while all the controls were quite healthy. At the close of the experiment after 6 months, the average length of root of the control plants was 2·9 inches while in the pots with dead leaves the average length was 1·4 inches only.

The effect of carbon dioxide on the root development of *Sandal* (*Santalum album*) seedlings was also tested by growing the latter in water cultures and bubbling the gas through the culture solutions for 10-15 minutes daily. After a period of 6 weeks, the 14 control plants were all quite healthy whereas all the 14 plants in the injected solutions had their roots extensively decayed. At the close of the experiment the concentration of the carbon dioxide was 500—1,300 milligrams per litre.

Forest Grasses.—During the year, the Forest Botanist visited the grasslands on the banks of the Brahmaputra in the neighbourhood of Goalpara and identified the dominant species. The chief species is *Saccharum spontaneum*, Linn. the subsidiary species being *Phragmites Karka* Trin., *Saccharum arundinaceum*, Retz, and *Saccharum fuscum*, Roxb. All of these are suitable for paper-manufacture and a supply amply sufficient for a pulp-factory appears to be available. A cutting rotation of 2 years is suggested as most suitable to commence with and local experiments have been prescribed for the purpose of finally determining the best rotation most suitable to the local conditions. In connection with a scheme to work *ulla* grass (*Anthistiria gigantea*, subsp. *arundinacea* Hack.) for paper pulp, experiments were initiated in the Pilibhit Division of the United Provinces last year, in accordance with the Forest Botanist's suggestions, for the purpose of determining the most suitable rotation. In the case of this grass, at the time of cropping in the cold season, the plants usually contain a number of immature green leafy culms. The cutting of these decreases the dimensions and yield of flowering culms while the inclusion of them in the cut crop is also undesirable from the point of view of the pulp-manufacturer, inasmuch as they cause agglutination and interfere with the bleaching. In addition to damage by cutting, this grass is locally very liable to fire damage. Fire injures the plants directly by destroying and

damaging the culms and rhizomes and indirectly by drying the soil and increasing the damage by grazing of the young shoots in the hot season by deer and other animals. The results of the first year's experimental working are strongly in favour of a treatment of annual cuttings of flowering and dead culms only, coupled with fire protection, the immature leafy culms not being cut, and it seems probable that this will be the best system to adopt.

Sissoo Root-disease.—During the year the Botanist visited the Changa Manga plantation in the Punjab where the Sissoo (*Dalbergia Sissoo*) has long been suffering from the attacks of the root fungus *Fomes lucidus*, Fr. In these irrigated plantations, under the system of working now in force, the conditions of water-supply are by no means ideal for Sissoo, at some periods of its growing season there being too much water and insufficient soil aeration, while at other times there may be a deficiency of water. This irregularity it is believed increases the susceptibility of the tree to the attacks of the fungus.

It is interesting to note that Petch, some years ago in Ceylon when studying the root disease of the Coconut Palm caused by this same fungus, reported that it occurred "under both extreme conditions of water-supply, but not under intermediate, more normal, conditions." Experiments have been initiated at Dehra Dun to test the susceptibility of Sissoo to the attacks of the fungus under different conditions of soil moisture and æration. With the help of local officers it is also hoped to start experiments with different methods of irrigation and meanwhile it is at all events advisable to see that, in all sites selected for new plantations, all old stumps are first rooted out and burnt and to prevent as far as possible infection being brought from outside in the canal water or otherwise.

Spike Disease of Sandal.—Dr. Coleman published an important paper during the year describing the experiments in which he succeeded in communicating the spike disease to healthy sandal plants by grafting them with spiked branches.

Systematic.—The two descriptive lists for the Central Provinces were published during the year and Mr. Parker's forest flora of the Punjab is in the Press. The Botanist read a paper on the Indian species of *Iseilema* at the Science Congress held in Bangalore in January. The species of this genus have been much confused in the past and in this paper emphasis was laid on the fact that systematic work on the accurate definition of species is essential for economic development. Incidentally also such work is of scientific importance in its bearing on the question of the origin of species.

BOTANY.

II.—ECONOMIC BOTANY.

III.—Mycology and Plant Pathology.

BY

E. J. BUTLER, M.B., F.L.S.,

Imperial Mycologist.

Agricultural Research Institute, Pusa.—The following is an account of the chief investigations at Pusa during the year.

Ufra of rice.—The investigation of "ufra," a disease caused by an eelworm, *Tylenchus angustus* Butl., was continued by the writer in collaboration with the officers of the Bengal Agricultural Department. During the year, it has been traced across the Megna into the districts of Bakerganj and Faridpur, as far as the borders of Kulna. Five districts, Noakhali, Tippera, Dacca, Faridpur, and Bakerganj, are now known to be infected, and extension is probably going on into Mymensingh, Kulna, and Sylhet.

Enquiries were directed to elucidate some of the anomalies observed in the parasitism of the worm. It has been confirmed that the spring or "boro" crop escapes, although often exposed to infection from a previously diseased "aman" or winter crop, and that, in general, the transplanted varieties are not attacked. It has been established that the "boro" crop, grown under irrigation during the dry months from January to April, avoids damage merely because the worms are unable, in dry weather, to leave the water to climb up to the susceptible parts of the rice plant, which are towards the top of the shoot. Experiments have proved that the worm can live for at least 8 months if fully dried and for much less—probably less than 2 months—if totally immersed, but that under such conditions it neither feeds, nor grows, nor reproduces. In very humid air, however, it moves readily outside the water, and it is only in really damp weather that migration to the above-water parts of the rice plant occurs, and that feeding and reproduction become possible. Hence the active life of the worm is confined to the period from June to November, when humidity is high, and for the rest of the year it remains quiescent or at most, if it reaches water, swims about for a few weeks without feeding or multiplying. Thus, though it is possible that there is some infection of the young "boro" seedlings in the first month after they are transplanted, no further injury can be caused once the dry weather comes, and the crop matures in safety.

In some areas, the period of active life may be prolonged into February, since there exist low-lying patches which do not dry out after the annual innundation until February, and a second growth of small shoots with dwarf ears comes from the winter paddy stubble in such spots. The heavy night dews of December and January allow of infection of this second growth, but by the end of February even it ceases to support the parasite. Leaving aside these areas, the broadcasted winter rice lands usually dry out in December, and the parasite remains quiescent in the dry stubble until the next crop is put in, in March or April. It then resumes active motion, but the experiments indicate that infection of the growing crop does not occur before May, when the rains usually break in these districts and humidity rises enough to permit of migration. By June, attacks on the maturing "aus" or autumn paddy are visible and by July they can be found in the still immature winter crop. They would doubtless be observed a month or so earlier, were it not that the symptoms of infection are not easily recognisable in immature plants and that, since multiplication does not begin much before June, the early attacks are usually mild. *In transplanted paddy conditions are different.* The transplanted rices (leaving out the "boro" and the rare transplanted "aus" kinds) are usually put out in August in relatively high fields. After harvest, these fields carry little stubble and are well cultivated as compared with the lower land. Experiments have shown that removal of the stubble is usually effective in preventing the disease and the few worms that may be left behind are ploughed in early and do not survive long. Occasionally a transplanted field becomes attacked (usually, no doubt, by spread from a neighbouring low field as the flood rises) but such attacks are rare and the parasite is not likely to survive until the new crop is put out in the following August. Hence the immunity of transplanted paddy is due to the relatively high level at which it is grown, to the more complete removal of the stubble at harvest, and to the early and thorough cultivation given to the fields in the spring.

Where the land dries out in December (as in most of the infected tract), the removal or burning of the stubble, combined with early cultivation, is the best way to combat the disease. This method has been entirely successful in a number of experiments carried on at Pusa and Dacca, and promising results have also been obtained on a field scale in several infected areas. In the low-lying patches, which do not dry out by the beginning of the year, it has failed. The failure is due to the difficulty in burning the wet straw and in cultivating the muddy soil so as to cause the debris to decompose. In such places, the worm has normally only to go through a month or two between death of the second growth from the stubble and the germination of the new crop. Hence early attacks occur, and each such patch serves as a focus of infection. To deal with these cases, experiments are being undertaken in two directions. Where a permanent water channel can be cut, the fields along its banks may be lowered and embanked so as to grow the immune "boro" crop; and where this is impracticable, the swampy patches may be drained so as to permit of early cultivation and stubble-destruction.

Other remedial measures being tried comprise the growth of early maturing kinds, which escape severe damage owing to their short growth period not allowing of much multiplication of the parasite; the encouragement of jute cultivation, with a view to establishing a rotation; the encouragement of transplantation; and the more extensive growth of cold weather crops. An account of the investigation to date has been prepared for publication. It is of interest to note that a second species of *Tylenchus*, agreeing in its main features with the peculiar mode of life of *Tylenchus angustus*, has recently been recorded attacking black currants in England, and it is probable that other cases will be found.

Orobanche on tobacco and Brassica.—Further experiments were carried out by Dr. Shaw with the object of testing the claim that sodium nitrate is a specific against this pest. The results of the previous season's work had been partly obscured by the fact that the amount of *Orobanche* appearing in a plot seemed to depend as much upon the degree of infection in the soil as upon the influence of any application of sodium nitrate. During the season 1916-17 the experimental plots were so arranged, in the light of the information gained during the previous season, that this factor was eliminated. It was then found that the amount of *Orobanche* which came up in any particular plot depended largely upon the degree of infection in the soil and was practically uninfluenced by any application of sodium nitrate upon an agricultural scale.

The species of *Orobanche* examined were *O. cernua* Lœfl, and *O. indica* Ham, and, as in the previous season, the former proved to be restricted to *Solanaceæ* while the latter occurred principally upon *Cruciferæ*, and only to a modified extent upon *Solanaceæ*. With a view to testing the parasitism of these species in greater detail than was possible within the limits of a field experiment, a series of pot cultures was carried out. Four host plants were used, namely tobacco, cabbage, mustard, and turnip, and these host plants were infected with seed of *O. cernua* and *O. indica* which had been collected from *Orobanche* parasitic both upon the species of host plant infected and upon the other three host plants. Thus pots containing tobacco plants were infected with seed of *O. cernua* collected from *O. cernua* upon tobacco, and with seed of *O. indica* collected from *O. indica* upon mustard, from *O. indica* upon tobacco, from *O. indica* upon cabbage, and from *O. indica* upon turnip. The same treatment was applied to mustard and to the other host plants. The results showed that *O. cernua* was strongly parasitic upon tobacco, and did not attack the other three hosts; while *O. indica* was not parasitic upon tobacco unless the seed used had been collected from plants which were parasitic upon this host, in which case such seed was not capable of infecting mustard plants. Seed of *O. indica* collected from plants parasitic upon either mustard, cabbage, or turnip, however, would not infect tobacco but was strongly parasitic upon all of these hosts. Thus there appears to be two races, or strains, of *O. indica*, one parasitic upon tobacco and not infecting mustard, and the other parasitic upon mustard, or the allied cabbage and turnip, and not infecting tobacco. Certain of the pot cultures received heavy applications

of sodium nitrate, which, however, did not have any marked effect upon the occurrence of *Orobanche* ; the details and results of all the above experiments are now in the press.

Phytophthora investigations.—Mr. Dastur has continued his studies on this important genus. The " Black Thread " disease of Para rubber trees is fully described in the " Memoirs " and, as a result, the attention of other workers has been directed to the similar condition prevalent in Ceylon and Java. It seems clear that the disease is found in most parts of the East where rubber is grown, but the Java workers still hold that it is due to the same parasite that causes rubber and cacao canker, and is not a new disease. Mr. Dastur has given reasons for believing the parasite to be a distinct species, a matter of considerable economic importance since the canker fungus is common especially in the neighbourhood of infected cacao trees. He has found the Black Thread fungus to be much more restricted in its parasitism than *Phytophthora Faberi* (the canker fungus) and has quite failed to get it to attack cacao and other hosts of the latter. The remedial measures recommended are being tested on a plantation scale in Burma. The chief are the free admission of light and air amongst the trees by judicious thinning and the cessation of tapping during the monsoon months on all diseased trees. In South India, where the same or at least a closely allied species is under investigation, good results have been obtained by the application of antiseptic and waterproof smears to the cut surface left after tapping. Tar and tallow ; sulphur, cowdung and clay, have been used, and no doubt other more efficient mixtures will be found. It is not yet certain whether similar measures will be required in the relatively drier parts of the Burma rubber districts and, at the time of writing, Mr. Dastur is carrying out further enquiries in Burma.

A second Memoir contains an account of a biologic variety of *Phytophthora parasitica* Dastur, found in Pusa on *Vinca*. It is a weak parasite, inoculations failing as a rule unless the atmosphere is almost saturated with moisture, but succeeding in damp air on a considerable number of garden plants. The fungus is, therefore, of more scientific than economic interest.

In a third paper, Mr. Dastur discusses the conditions influencing the distribution of *Phytophthora infestans*, the cause of the common potato blight. In India the fungus is ordinarily restricted to the Himalaya, Khasi, and possibly Nilgiri Hills, but periodical outbreaks have been observed in the Gangetic plain and the valleys of Assam and Sylhet. An analysis of the conditions leading to these attacks indicates that temperature, moisture, and source of origin of the tubers are all important factors in controlling the distribution of the disease. Long exposure to temperatures above 77° F. is already known to be fatal to the fungus, and such temperatures are usually found at the time of sowing the plains' crop. Furthermore, damp weather at the period of fructification of the fungus (January and February in the plains) is necessary to permit free reproduction and dissemination. And unless the tubers come from some already infected area, such as the Himalaya or Khasi Hills, they are not liable to contamination and they will escape disease in the plains,

since the plains' crop is normally free and local infection not usually to be feared. The outbreaks investigated showed that the seed used was probably infected, that it was brought from the Hills when the temperature below was under the normal for sowing time, and that the crop was exposed to rain or ground fogs as it ripened. Unless all these conditions are met, the crop may be expected to escape in the plains and in most of peninsular India.

Rhizoctonia and allied fungi.—Evidence was obtained that the jute disease caused by *Rhizoctonia* is associated, in severe attacks, with deficiency of some soil constituent, and the enquiry is being continued by Mr. Finlow, Fibre Expert to the Government of Bengal, who has obtained results pointing to potash as the constituent in question. Soil conditions are probably also concerned in the cotton disease known as "root rot" in northern and western India, which is frequently associated with the same fungus. The writer visited the Punjab in connection with this case. Dr. Shaw has continued his study of the sclerotial diseases of sugarcane and rice. At least three distinct forms attack sugarcane, one being identified as *Rhizoctonia destruens*, while the other two have not yet been named. One of these latter (or a very similar species) has also been found attacking rice, and all these, together with some other species obtained on various crops during the year, are being submitted to comparative study.

Anthracnose of Chilli and other crops.—The chilli disease at Pusa ascribed in last year's report to *Colletotrichum nigrum*, has since been determined, with the aid of the United States Department of Agriculture, to be due to a distinct fungus. The latter has now been identified with *Vermicularia Capsici*, already known in Madras, while the true *Colletotrichum nigrum* has been found recently in Burma. A third allied form, *Glomerella piperata*, occurs sporadically throughout India. It has been decided to restrict the name "anthracnose" to the diseases caused by the last two (which are doubtfully distinct) and to call the *Vermicularia* disease "die-back." Die-back is much the worst of the three, and experiments have been continued with a view to obtain a satisfactory treatment. Seed selection, from which much was hoped, has failed, but it has been found that one or two sprayings with Burgundy mixture at the end of the rains give good results. Further experiments are in progress. The same confusion in regard to the fungi causing anthracnose in pulses and *Solanaceæ* appears to prevail. *Vermicularia Capsici* has been found to attack these plants and to cause a disease resembling the anthracnoses to which they are also subject. Mr. Dastur is carrying out a detailed study of these forms.

Sal tree disease.—Dr. Shaw has continued his work on this disease, which appears to be causing increasing damage in north Bengal. The life history of *Polyporus Shoreæ* is being followed out in culture and its parasitism tested by inoculations in the forest. The work has not yet given definite results.

Miscellaneous.—Extensive trials of spraying against peach leaf curl were carried out near Peshawar by Dr. Shaw, in co-operation with Mr. Robertson

Brown, Agricultural Officer, North-West Frontier Province, the results being distinctly encouraging. Powdery scab of potatoes, caused by *Spongospora subterranea,* was recorded from Bombay for the first time in India. This is the first parasitic Myxomycete found in the country. The suspected cause of the soft rot disease of ginger has been isolated and its parasitism established not only on ginger but on chilli, tobacco, and other plants. It is a *Pythium,* allied to *P. gracile.* Several parasites of tea and coffee, not hitherto known to occur in India, were identified, amongst them being *Rosellinia bothrina, Sphærostilbe repens,* and *Cercospora coffeicola.* The writer has published an examination of the factors controlling the dissemination of parasitic fungi and of the legislative measures which may be applied to the protection of crops against introduced diseases. Two types of dissemination are distinguished, continuous or short-range and discontinuous or long-range. For the former, fungi are so well equipped that measures to check it are likely to prove abortive. For the latter, however, human activity as displayed in the moving of living plants from one part of the world to another, is by far the most important factor and is susceptible of control. A detailed examination of the history of many of the chief diseases of economic plants which have appeared in recent years, shows plainly that they follow the trade routes and are closely bound up with movements of living plants, conveyed by traders, botanists, and settlers. It is open to question whether the benefits thus gained are not outweighed by the losses caused through the introduction of disease. The application of legislation to the checking of this danger is discussed at length, with particular reference to the International Phytopathological Convention of Rome, drafted in 1914.

Other Scientific Departments.—The following are the chief items of mycological work carried out by other scientific departments, chiefly Departments of Agriculture.

Madras.—The following note has been communicated by Mr. McRae, Government Mycologist.

" The cultural work on *Ephelis Oryzæ* Syd. has been advanced, but the whole series of inoculations on paddy in the field this year has yielded no definite results. *Fomes australis,* a fungus produced on dead plants of *Coffea arabica,* has been brought into culture and has fructified in culture. The mycelium from a culture inoculated on the roots of *Grevillea robusta,* a common shade tree of coffee estates, infected them, but on the roots of *Coffea arabica, Acacia decurrens,* and *Zizypus rugosa* it did not on those examined, and the others have as yet shown no outward sign. Inoculations will be repeated during the rains. The fungus has also been found on orange trees that had recently died. The method of control of the fruit disease of *Capsicum frutescens,* caused by *Vermicularia Capsici,* is being worked out in the field. Bordeaux mixture, when sprayed evenly enough, prevents the fungus from attacking the fruits but, as the fruits are produced over a long period, spraying, to be effective, has to be done several times.

"The species of *Phytophthora* found on *Hevea brasiliensis* has been found to be parasitic on Hevea as a fruit-rot, a leaf disease, a die-back of branches, and a bark rot. The fungus lives through the dry weather as mycelium in the branches that have died back and as resting spores in the fruits. Experimental work with a view to check the fungus is being done this year on 350 acres of planted *Hevea*. Dead branches were removed after the flush of leaves developed, and fruits were removed before the coming of the rainy season. By inoculation, the fungus has been found to be parasitic on *Manihot Glaziovii* (Ceara rubber)."

Notes on some South Indian fungi of interest are published by Mr. McRae in the Year Book of the Madras Agricultural Department.

Mr. Sundararaman has contributed to the last-named publication a note on the common Sorghum smut, *Cintractia* (or *Sphacelotheca*) *Sorghi*. He estimates the loss at 10 per cent. of the crop in many districts and gives an account of its characters, mode of infection, and control. Copper sulphate, formalin, and hot water have all proved effective in seed disinfection and properly used will give a crop free from smut. For practical reasons he advocates the first named, used in 2 per cent. solution, the period of immersion of the grain being 15 minutes. He shows that this cereal is very resistant to copper sulphate, germination being unaffected by strengths more than sufficient to kill the fungus.

Mr. Anstead, Deputy Director of Agriculture, Planting Districts, carried out the following work in the Scientific Department of the United Planters' Association of Southern India.

The brown blight of tea, caused by *Colletotrichum Camelliæ*, has recently become prevalent on tea estates and has caused considerable damage, especially to nurseries. Hitherto it has been looked on as a minor pest and the conditions leading to its sudden virulence are not understood. It has been studied in co-operation with Mr. McRae, and recommendations for treatment made. In nurseries, it is recommended that as soon as the disease appears, all attacked leaves should be picked off and burned and the plants then sprayed with Bordeaux mixture. The nurseries should be kept open to light and air, free from weeds and fallen leaves and as dry as the plants will stand. Liming the soil is also advantageous. After the plants are put out as supplies or in new clearings, the same general measures are required. In old tea, when the attack is severe, prunings and fallen leaves should be burned, the ground limed at the rate of 5 cwt. per acre, rapidly acting nitrogenous manures avoided and phosphates and potash (or wood ash) applied. Very successful results have been obtained by these measures on an estate scale.

Grey blight of tea, caused by *Pestalozzia*, is often mingled with brown blight and can be controlled in the same way.

Coffee black rot (*Corticium Koleroga*) and leaf disease (*Hemileia vastatrix*) have also been attacked by spraying. The experiments have shown that the former disease can be successfully controlled with Bordeaux mixture combined

with regular pruning. Leaf disease, however, is more troublesome. If large areas, up to 100 acres or more, can be sprayed before the attack begins, the disease is lessened and after some years of regular treatment it would probably be reduced to negligible proportions. On a small scale, however, the sprayed patches are quickly reinfected from the untreated areas.

Experiments in the control of the *Phytophthora* disease of rubber were carried out in co-operation with the Government Mycologist. Four large plots were taken up in different localities in 1917 and various methods of treatment are being tested. No results can be expected as yet.

An attack by a species of *Glœosporium* occurred on a tea estate two years ago and caused a severe leaf-fall. It was treated by removing diseased and fallen leaves and spraying. Then the dead wood was pruned out, the soil cultivated, and lime and nitrolim added. This was successful at the time, but a new attack developed this year. It is uncertain whether the disease is a new one ; it seems to resemble in some respects a disease which does considerable damage at times in Assam but has not, as yet, been studied scientifically.

Mysore.—Dr. Coleman, Director of Agriculture, has published a bulletin giving the results of the preliminary investigations of the " spike " disease of sandal, a disease which threatens the existence of this tree in South India. After giving an account of the origin and spread of the disease and reviewing previous work, the author discusses the histological changes in the tissues of affected trees and notes the evidences of profound physiological disturbances in their metabolism. The chief of these is the presence of abnormal quantities of starch in the tissues. This feature has been correlated with diminished diastatic activity of the diseased, as compared with healthy, leaves, so that the starch formed is not sufficiently translocated. There is probably also an actual increase in carbon assimilation in the early stages of the disease, though the evidence on this point is not yet fully available. No parasite has been found, and the author inclines to the view that the cause is a virus whose active principle is an ultramicroscopic organism. The similarities between " spike " and certain other obscure diseases, such as " peach yellows ", are noted and experiments described showing that infection can be obtained by grafting a diseased branch on to a healthy stock, as in the last-mentioned disease. Infection by other means has so far failed. No evidence was obtained that external conditions of soil, climate or the like have any connection with the disease, beyond increasing its virulence, but it has been conclusively proved to be an infectious disease. How it spreads is not known, but diseased trees are a danger and should be promptly removed. This is the only recommendation that can be made at present.

Dr. Coleman's work on black rot of coffee, caused by *Corticium Koleroga*, mentioned in last year's report, has been written up and will be published shortly. A note on the fungi attacking green bug (*Coccus viridis*) will also, it is hoped, be issued soon.

Practical measures against areca palm diseases were continued. Considerable promise of success against the root disease (caused by *Fomes lucidus*) by trenching and liming heavily, has been obtained. The campaign against Koleroga (caused by *Phytophthora Arecæ*) has yielded excellent results. In one garden the disease has been stamped out, no case having occurred for two years; and others that have remained free under treatment for several years will now be left alone to see if there is any recurrence.

Bombay.—Mr. Ajrekar has continued the study of a disease of citrus trees associated with a species of *Nectria*. Inoculations with this fungus have so far failed. The disease was successfully treated by spraying with Bordeaux mixture and resin just before the rains. He has also attempted to establish a relationship between a *Sphacelia* which is parasitic on ears of jowar and a *Cerebella* found in the same situation. It is still uncertain however, whether the latter fungus is not merely a parasite or epiphyte on the former. Other research work by this officer included enquiries into a cardamom disease in Kanara, the connection between *Fusarium* and the scab of citrus (which recent work at Pusa has shown to be ordinarily a bacterial disease) and the life history of *Ustilaginoidea virens* on rice. The note on the use of copper sulphate in preventing sugarcane smut, referred to in last year's report, has been published.

Messrs. Ajrekar and Kulkarni have commenced the study of the rotting of stored potatoes. So far three rots have been distinguished: a dry rot due to *Fusarium*, another due to *Rhizoctonia*, and a wet rot, which is bacterial.

Mr. Kulkarni has completed and submitted for publication his study of the smuts of jowar (*Sorghum*) in Bombay. The fungi concerned are *Sphacelotheca Sorghi*, *S. cruenta*, *Ustilago Reiliana*, and *Tolyposporium filiferum*. A more detailed account of the work is deferred until next year. This officer has also continued the campaign against "Koleroga" disease of areca palms, 12,000 trees having been sprayed against 9,000 the previous year. A small plot has been taken up in Surat district for the selection of sugarcane against red rot.

Mr. Patwardan was in charge of operations against grape-vine mildew, and has commenced work against vine anthracnose. The operations have been extended from Nasik to Satara and continue to give very satisfactory results.

Central Provinces.—The work of this Department was carried out, in the absence of a mycological staff, chiefly in the direction of identifying diseases with the assistance of Pusa, and in isolating disease-resisting varieties of crops. Much damage was done to rice by *Sclerotium Oryzæ* and steps are being taken to find resistant varieties. Promising varieties of rust-resisting wheats are now being tested at Jubbulpore. The destructive fungus, *Cercospora beticola*, was recorded for the first time in India and the perfect stage of the peach rust obtained, also for the first time. Citrus diseases were

observed, the chief being an attack of *Rhizoctonia* on lemon seedlings and a disease of citrus stocks in the Nagpur nursery which may be due to *Phoma macrophoma*. "Foot rot" did slight damage at Tharsa.

Indian Tea Association.—Mr. Tunstall, the Mycologist of this Department, has continued his investigation of the root diseases of tea. He has succeeded in obtaining the perfect stage of one species of *Rosellinia* parasitic on this plant and also in obtaining material and cultures of the red rot disease, which permitted of the identification of the parasites at Pusa as *Rosellinia bothrina* and *Sphærostilbe repens* respectively, both new to India and the latter new for tea. The former is prevalent in Darjeeling, but is not the only *Rosellinia* attacking tea in India. It can be checked in early stages by liming and clean cultivation. *Sphærostilbe* occurs in stiff, acid soils and can be checked by removing diseased bushes and liming the soil.

A disease of tea stems in Darjeeling and the Terai has been found to be due to a *Nectria* which spreads from certain shade trees. It is a wound parasite of tea, entering at the wounds made by pluckers and extending down so as to kill the bush in two or three years. It can be stopped by pruning out diseased stems and applying lime-sulphur solution immediately. This treatment was successful on a large area in the Terai and is being widely adopted.

The practical methods of blight prevention received much attention but progress was slow, owing to the war. A scheme for general co-operative blight treatment was favourably received by the Darjeeling Planters' Association and experiments on a large scale have been arranged for.

Other work included observations on the dissemination of blister blight, experiments on the effect of general spraying treatment on the yield of tea, and an enquiry into the cause of deterioration of certain bheel gardens in Cachar and Sylhet.

AGRICULTURAL BACTERIOLOGY

BY

C. M. HUTCHINSON, B.A., M.A.E.B.,

Imperial Agricultural Bacteriologist.

WORK AT PUSA.

Soil fertility in its relation to bacterial activities.—This included further work upon nitrification with special reference to the interference with this process resulting from—

(1) The absence of the necessary specific organisms in some soils.

(2) The inhibiting action of toxins produced in soils under semi-anaerobic conditions.

The apparently complete absence of nitrifying organisms in certain soils was certified and confirmed by continued examination of further samples in which nitrification of added organic matter was secured only after inoculation with nitrifying organisms derived from other soils. The principal feature of such soils probably responsible for the absence of nitrifying organisms is the bad texture making good tilth difficult to obtain; added to this is a deficiency of lime. Both these objectionable features would have to be modified by cultivation, growth of green manures, and addition of lime, before inoculation of the soils could be attended with success. Defective nitrification was found especially marked in certain soils from Ranchi.

Soil I.—Did not form any nitrate at all either with ammonium sulphate or cake, even on addition of lime. Inoculation with Pusa soil produced nitrification of 75 per cent. of ammonium sulphate and 90 per cent. of cake nitrogen in six weeks time.

Soil II.—This soil failed to produce any nitrate from ammonium sulphate in six weeks, but nitrified 50 per cent. of added cake nitrogen in this time, probably owing to the introduction of nitrifiers with the cake. Inoculation with Pusa soil resulted in complete nitrification of the ammonium sulphate in six weeks and of the cake in four weeks. In this soil addition of lime increased the rate of nitrification.

Soil III.—This soil nitrified 25 per cent. of added ammonium sulphate nitrogen in four weeks; inoculation produced complete nitrification (100 per cent.) in the same time.

Soil IV.—15 per cent. ammonium sulphate was nitrified in six weeks; inoculation produced complete nitrification in the same period.

The addition of lime alone produced increased nitrification in the soils 2, 3, 4 but had no effect on soil 1, nor was the addition of lime only in any case as efficacious as inoculation.

Barley and maize germinated and grew well in these soils for one week, after which growth stopped, the seedlings lost colour and all died after three weeks.

The effect of toxins produced by bacterial action upon nitrification was further studied. It was found that soil plus organic matter incubated under semi-anaerobic conditions gave a water extract which considerably lowered the rate of nitrification when added to another soil. This extract, on being made alkaline with caustic soda, gave a white precipitate, containing more than five per cent. nitrogen; this substance has a decided retarding effect upon nitrification. Acidification of the filtrate from the above yielded a white crystalline substance soluble in dilute acids and containing rather more than four per cent. of nitrogen; this substance was found to increase the rate of nitrification in Omelianski solution.

Phosphate requirements of soil bacteria and their relation to plant growth.—A series of experiments dealing with this subject was initiated; the results so far obtained did not suggest that solubilization of tricalcic soil phosphates by bacterial action is sufficient in amount to produce a surplus supply of soluble phosphate for the direct use of higher plants, but rather that the bacteria dissolve only sufficient for their own requirements. It seems clear, however, that such important fertilizing bacterial actions as nitrification depend for their occurrence in any useful degree upon proper supplies of phosphatic bacterial food, and it is also clear that carbonic acid resulting from bacterial action in the soil will in course of time solubilize sensible quantities of mineral phosphate.

Biological analysis of Soils.—Numerous samples of soil were analyzed by the method elaborated in this laboratory; much useful information has been obtained in this way as to the close relation between bacterial activity and soil fertility. Application of the method to Reh soils in the Punjab was found of great value by the Agricultural Chemist to the Government of the Punjab, whose assistant had been trained in its use in this laboratory. It is to be hoped that the untimely death of Mr. Barnes, whose criticism and advice in connection with the chemical methods involved were of great value to me, will not prevent a continuation of this enquiry.

Familiarization with the use of the method forms a useful preliminary training for students in this section.

Green manuring.—Field experiments on the modified method of green manuring devised in this laboratory, have been continued in collaboration with the Imperial Agriculturist on the farm, and also in the bacteriological area, where a very large crop of Java indigo was obtained by its use; this crop was not only heavier than those obtained on control plots manured with

cake, but on analysis by the Indigo Research Chemist was found to contain a higher percentage of indican.

Leguminous root nodule organisms.—Experimental work upon cross inoculation with different strains of Ps. radicicola was carried out by Mr. Joshi, First Assistant in this section. It was found that in several instances very substantial increase in growth both of roots and of the whole plant resulted from inoculation although characterized by complete absence of nodule formation. This was especially the case when cultures from one species of plant were used to inoculate a different species; it is suggested that this forms a case of incompletely developed symbiotic relationship due either to greater resistance to invasion on the part of the host plant, to less parasitic ability on the part of the invading organism, or merely to a lower degree either of stimulation by the parasite or of reaction to stimulus by the plant. The results of this enquiry will be published shortly.

Plant diseases.—Bacterial diseases of wheat, Poppy, and Citrus trees were under investigation during the year. A memoir on the first of these is now in the press.

Poppy.—Blackening and slimy decay of the stem and leaves of the opium poppy and other varieties was found to be due to bacterial rot; a description of the disease and of the causative organism is in hand for publication.

Citrus canker.—This disease has been known in India for several years; some forms of it were found to be due to the action of Ps. Citri well known as the cause of this disease in Africa and America where it has caused very widespread and serious damage. Further investigation will be made during the next year.

Indigo.—Work on this subject has been continued in collaboration with the Indigo Research Chemist and has afforded further confirmation of the importance of bacterial action in indigo manufacture.

It has been shown that the failure in factory practice to obtain nearer approximation to the theoretic yield of indigo from the plant is due to several factors of which the following have now been found to be of importance.

(1) Destruction of indican in the leaf during fermentation or steeping. This appears to be due to several causes all preventing the desirable change of indican by hydrolysis into indoxyl. These probably include the action of plant enzymes and bacteria other than those producing indoxyl from indican. With this source of loss may be associated

(2) Incomplete extraction of the indican, as although no residual indican may be found remaining in the plant after steeping, yet investigation has shown the very strong probability that its absence is due not to removal into solution in the steeping water but to actual destruction or decomposition *in situ*. This destruction appears to be due partly to enzymic and partly to bacterial activity other than that resulting in production of indoxyl.

Control of the fermentation taking place in the steeping vats must therefore take the form of introducing conditions which will minimise such losses, probably on the following lines.

(1) Promote rapid extraction and so remove the indican from deleterious surroundings in the leaf tissue.

(2) Promote rapid hydrolysis and so lessen the period of time during which the indican in solution is liable to conversion into products other than indoxyl.

Extraction.—Until the hot water extraction previously suggested as the most satisfactory method has been shown to be practicable on a factory scale, it seems necessary to rely upon the production of acidity by bacterial action in the steeping vat or possibly in the Khazana; mineral acids being too high in price at present for economic use. It has been found by the Indigo Research Chemist that extraction and acidity bear a close proportional relationship, and endeavour will be made either to isolate bacteria capable of combining acid production with indican hydrolyzing powers, or to use different species for these two purposes either concurrently or in succession.

Hydrolysis.—Numerous species of indican hydrolyzing bacteria were isolated by means of indican agar; these were tested for hydrolyzing power and arranged in a relative order taking into account not only this physiological function, but also the opposite destructive action which many of them possessed. There can be no doubt that the very large differences between yields of various factories are due mainly to differences in the composition of the bacterial flora in the steeping vats; how far this may be due to bacteria carried by the plant or to those existing in the *Khazana* water is not at present known, but examination of a large number of samples of the latter has demonstrated a very close connection between the actual yield of the factory and the number of hydrolyzing bacteria present in the water supply. Actual cases of increased yield as a consequence of inoculation of the vats of one factory with the steeped liquor from another of higher yield substantiate this view.

In order to make use of the inoculation method it will be necessary not only to obtain efficient species of bacteria but to ascertain the conditions under which it will be possible to introduce them into the steeping vat in sufficient numbers and in a sufficiently high state of activity to influence the style of fermentation therein. This will probably be difficult in view firstly of the very large volume of water involved (some seven or eight thousand gallons in each vat, and as many as six to twelve vats in use at one time) and secondly of the large number of other bacteria necessarily present already on the plant and in the water. As before pointed out it may be found necessary to remove the possibly deleterious influence of these latter, by use of hot water extraction, but the economics of this method would have to be worked out before recommending its adoption as a factory procedure.

It became clear very early in the enquiry that no advance could be made in the absence of an experimental factory. Designs were accordingly made and sanction obtained for the necessary expenditure ; it is unfortunate that owing to various and numerous sources of delay it has not been found possible to complete the erection and equipment of the factory in time for manufacture of Java plant at the time when it was ready for cutting ; it is hoped that even with over mature plant some results of value may be obtained. The factory consists of one range of six vats with six corresponding separate Khazanas and blowing vats. Four vats are of 100 cub. ft. capacity and two of 50 cub. ft. Blowing was preferred to beating on account of the mechanical difficulties of the latter in several small vats, and of the greater possibility of controlling the oxidation and ensuring comparable conditions in all the vats.

Apart from the actual indigo produced the Indigo Research Chemist has kindly undertaken to arrange for complete analytical control of the whole series of operations in each experiment, which will naturally afford more insight into the causes underlying differences in the results obtained by variations in the method of manufacture than could be secured merely by weighment of the indigo produced.

The lines of enquiry which will be adopted will aim at determining :—

(1) The possibility of increasing the yield of indigo by introducing specific bacteria into the steeping vats.

(2) The best way of doing this on a factory scale and under factory conditions.

There are indications that the second part of this enquiry will form the major problem and may require a considerable amount of time and labour to bring to a successful issue. It is also evident that should hot water extraction prove economically feasible the difficulties connected with its solution would be greatly reduced in number.

Pebrine.—Further work on this subject was carried out and a Bulletin describing a revised method of examination of moths was published.

The rearing of worms (mulberry) was continued under controlled conditions with a view to determining the following points in connection with the incidence of pebrine.

Some 90 lots were reared under controlled conditions besides many larger broods in a separate *kutcha* house.

Hereditary infection.—Broods were reared throughout the year to check the value of the improved method of seed selection and to compare it with the one which has been unsuccessfully used in Bengal during the past ten years. The results of the experiments confirmed the previous conclusion that many cases of pebrine in the moth may escape detection by the ordinary method, which would not do so if examined by the revised one.

Further confirmation was also obtained of the conclusion that a considerable percentage of pebrinized seed may produce worms which can be success-

fully carried through to the cocoon stage if afforded sufficient space and suitable food, whereas comparatively unfavourable conditions of life such as are frequently found in rearing houses as a consequence of ignorance or carelessness, would have ensured their failure to spin. Such worms however cannot be used for seed production, the resistance to the disease consequent upon the favourable conditions of life seldom being sufficient to do more than prevent the rapid multiplication and spread of the parasite in the body of its host which characterises the disease in less suitable surroundings.

One of the inherent difficulties of this work is the unavoidable length of time required for the experiments ; this is due to the impossibility of ascertaining either the success of an artificial infection, or even whether the vitality of the pebrine parasite has been affected by treatment, until an obviously diseased condition has been produced in the worms as a result of the use of such infective material. This may require several weeks' incubation during which the difficulty of ensuring the absence of other sources of infection and the possibility of adventitious disease in the controls add uncertainties to the results and make numerous duplicates necessary.

Infection through contagion or ingestion of the parasite.—The necessity of work upon this second source of the disease will be realized when it is pointed out that perfectly healthy seed if reared in infected surroundings will give rise to worms which may die whilst still in the larval stage, before spinning ; it is the loss of time and the money thrown away upon feeding such worms for several weeks that has caused many thousands of silkworm rearers to forsake this avocation in favour of some less precarious mode of earning a livelihood. Numerous experiments under controlled conditions have confirmed my previously expressed conclusion that the principal if not the only means of infection other than by hereditary transmission is by ingestion of the spore form of the parasite with the food. In this country at any rate, there seems to be no need at present to assume that any other method is of serious consequence ; the prime importance of avoiding this one alone, and the great inherent difficulties of doing so, will sufficiently engage the attention of rearers for some years to come.

Experiment here has not only shown the infective nature of the pebrine spore, in India as in Europe but has demonstrated its presence in great numbers in the dust of rearing houses and what is still more important in that of seed selection buildings. Most of these loose spores are thrown out of the gut of the infected but still feeding worm, along with the faeces, and being present in the latter in enormous numbers remain to some extent upon the leaves upon which the diseased and healthy worms alike are feeding. This naturally results in their passing with the food into the gut of the hitherto uninfected worms to act as sources of disease. Thus hereditary infection of a small percentage of worms becomes a source of disease for a much greater number and for this reason alone would require suppression.

Infection once introduced into a rearing house is carried on and spread through the agency of dust, human beings, and insects, carrying the spores of

the disease, not only from one part to another part of the same house, but almost certainly to other houses in the same neighbourhood. Similarly the spores may be spread through widely separated areas to a lesser distance by wind, but to unlimited ones by infected material such as cocoons and seed eggs sent by post, the latter material, although hereditarily free from disease, possibly contaminated during examination. My own observations in seed selection nurseries, lead me to conclude that this is by no means an unlikely means of spread of infection, aggravated in most instances by the faulty technique of examination which results in the accumulation of infective material in the selection buildings.

The persistence of infection in a rearing house will depend upon several factors about which at present very little is known, but as to which further information must be obtained if any success is to attend the efforts of rearers to avoid losses by diminishing the sources of infection. Nothing is known in India as to the action of the various antiseptics, such as copper sulphate, at present occasionally used for the disinfection of rearing houses. It has been assumed that they are efficacious, but so far as I have been able to ascertain this assumption is based, like the examination of moths, upon another one, that what is good in Europe is good in India ; there is more reason indeed for assumption in the case of antiseptics than there was for the other one connected with seed selection, but it would seem highly desirable to test the efficacy of such antiseptics as are available and reasonably cheap, by actual experiment. Owing to exigencies of other work I have been obliged to confine experiment during the past season to another, and what appeared to me to be a more important point, namely the viability or persistence of infective power of the pebrine spore under varying natural conditions ; this point seems to require elucidation as a necessary preliminary to such enquiries as the one above referred to, and the success of antiseptic measures would largely depend upon their having been devised with due knowledge of the resistance of the resting stage or spore form of the parasite to natural antagonistic or destructive agencies such as desiccation or heat.

Progress in experiment on this subject is necessarily slow for various reasons. Firstly must be taken into account the fact that no means is at present known of determining either the vitality or the infective power of this protozoal parasite except by the success or otherwise of experimental infection of its natural host ; this at best requires several weeks to show any positive result, and in any case may fail to do so from causes other than loss of infective power or vitality by the parasite, such as unduly high resistance of individual hosts, making it necessary to use large numbers of the latter to eliminate this source of error as far as possible. Numerous other disturbing factors have to be allowed for such as the possibility of accidental infection from adventitious causes either in the worms under experimental infection or in the controls. Further work on the purely protozoological side of the question is required before absolute knowledge of this part of the problem can be obtained, and this in my opinion must be carried out, and carried out in India, before it

will be possible to advance in actual practice much beyond the present empirical stage of treatment.

So far I have been able to ascertain with some certainty a few important points with regard to the persistence of vitality of the infective organism, amongst which may be mentioned the interesting fact that desiccation for as much as six months did not destroy the infective power of the pebrine spore whereas moderate moisture at the same temperature rendered it innocuous in one month. It will be obvious that more complete knowledge of this sort would be invaluable in introducing any modifications in existing practice, especially those depending upon avoiding certain climatic conditions either by confining rearing to certain seasons or to certain districts. It might be possible to make use of this line of enquiry to elucidate what appears to me to be a problem of great importance in dealing with preventive measures not only for this but for many other parasitic infections, especially those of cultivated crops. Many parasites, both animal and plant, go through a resting stage in their life cycle frequently in the spore form, as in the case of Nosema and of many bacteria and fungi; this resting condition usually serves the purpose of carrying the organism through a period of existence during which its surroundings are unfavourable for continued vegetative activity, either by reason of failure of food supply or of seasonal or climatic changes. Emergence from the spore condition normally takes place when conditions once more become favourable for active growth, and the time of such emergence is generally determined by the coincidence of some natural stimulus with such favourable surroundings. In the case of the pebrine spore the ordinary stimulus seems to be the combination of moisture and suitable temperature found in the gut of the silkworm, which initiate the series of internal changes in the spore culminating, under the added influence of acid found in the gut, in the protrusion of the flagellum and the emergence of the amœ bula. It seems probable that the deleterious effects of continued moisture upon the vitality of the spore may be due to prematurely induced resumption of vital activity in the latter, not indeed carried so far as germination, in the absence of other necessary stimuli, but resulting, in the absence of appropriate environment for its continuation, in either partial or total loss of vitality. Other similar cases of abortive germination are common in nature, and it would appear to be worth while to make a careful study of the possibility of artificially inducing it in such a way as to destroy various parasitic organisms, in cases where the use of antiseptics or heat is not practicable. It might for instance be found possible to induce premature activity in the pebrine spores infesting rearing houses, simply by moistening the walls and floor at a time of year when they would otherwise be completely dry, and although in the case of silkworm rearing the use of possibly more certain antiseptic methods is not generally prohibited by considerations of cost, in many other instances, such as occur in connection with agricultural operations, this principle might be worked out and applied where water, either natural or artificial, is available. Irrigation for instance might be utilized at the proper time to ensure premature germina-

tion of parasitic soil organisms, such as bacteria and fungi in the resting spore stage, or even to induce such unseasonable multiplication of the vegetative forms as to result in their exhaustion or auto-intoxication. This principle is actually made use of in the intermittent sterilization of bacterially infected substances and in the elimination of weeds from arable soil. It seems probable that similar premature or unduly rapid stimulation of embryonic activity may be responsible for the failure of crops in the seed bed or in the field, especially where germination has perhaps been inhibited by interference with the orderly sequence of enzymic activities characteristic of embryonic-metabolism, such interference being due to abnormal temperature or moisture.

In order to combine such knowledge with further information of a different kind such as the effect of climate or manurial treatment upon the nutritional value of the mulberry leaf and the resulting action upon the resistance of the silkworm to infection, much more investigation is necessary, but in view of the undoubted fact that the production of raw silk depends primarily in India just as it does in Europe, upon the possibility of avoiding diseases amongst the silkworms themselves, of which diseases by far the most destructive is Pebrine, it seems clear that such investigation is a necessary antecedent to any successful attempt to resuscitate the silk industry in India.

It may be said therefore that although an important step in advance has been made in the provision of an effective adaptation of Pasteur's classical method of seed selection to Indian conditions, yet the elimination of any undue percentage of hereditary infection by this means must be supplemented by the adoption of methods of rearing calculated to avoid subsequent infection, and such can only be carried beyond their present imperfect stage of development by making use of fuller knowledge of this subject than we at present possess. I regard more complete knowledge of the life-history of *Nosema bombycis* and the reciprocal relationships between this parasite and its host as an essential preliminary to any successful solution of the fundamental problem now confronting the promoters of the industry.

Saltpetre.—The artificial nitre beds described in a previous report (Bulletin No. 68 of the Agr. Res. Inst. Pusa) were kept under analytical observation during the year; they still continue to yield saltpetre and as this is remarkably free from sodium chloride, this method of adding to the output of saltpetre would have the additional advantage of inviting less attention from the Salt Department than is usually thought necessary in the case of extracts from village earth.

A *nuniah* was brought in during the cold weather and worked his ordinary process successfully with surface scrapings from these beds.

WORK IN THE PROVINCES.

Punjab.

The reclamation work on the Narwala farm in the Punjab carried out by the late Mr. Barnes, Agricultural Chemist to the Government of the Punjab,

was largely based upon a series of biological analyses of the alkali soils in the district. An account of the application of this method to this purpose is contained in a paper read by Mr. Barnes at the fourth Indian Science Congress in 1917 and published in the July number of the Agricultural Journal of India, 1917, in joint authorship with Mr. Barkat Ali who was trained in its use at Pusa with this particular object. Mr. Barnes shows in his paper the great superiority of the biological as compared with the purely chemical method of dealing with such subjects.

Central Provinces.

An account of some biological analyses of soils under special field treatment is given in the annual report of the Deputy Director of Agriculture, Northern Circle, Central Provinces.

In this case, it was desired to obtain information as to the effect of different treatments of soils in the field upon the biological factors involved, and also of the character of the bacterial complex already existent in such soils. This was found to possess a high order of nitrogen-fixing power, but low nitrate-forming efficiency ; it is not clear, however, from Mr. Plymen's report whether this latter characteristic is due to actual lack of nitrate formation or to a preponderating concurrent reduction to nitrite, so common in some soils. This work is to be continued on the same series of plots.

FORESTRY.

I.—SILVICULTURE.

BY

EDWARD MARSDEN,

Silviculturist.

Statistical work in typical Forest Crops.—Fifty new permanent sample plots and nineteen new temporary sample plots were laid out and measured during the year with the object of obtaining statistics relating to volume production. Most of the work was done in Bengal and Madras. Twenty different species were dealt with. Seventeen new permanent experimental plots were made, and twenty-nine existing permanent sample plots were remeasured. Observations when plots are remeasured are of considerable value, possibly of greater value than observations made at the original establishment of a plot. This year, suggestive *data* were obtained as to the effect upon increment of thinnings in dense *Sal* crops, and as to the relation between severity of thinning and degree of slope in dense coniferous crops at high elevations where injury from snow is to be feared. The investigation of tending is a branch of silviculture which is likely to have far-reaching economic results, and accurate observation at the time of remeasurement is at least of equal importance as accurate measurement.

Some interesting figures were obtained from pure crops of fast-growing softwoods. *Betula cylindrostachys* at 30 years has a mean annual increment of 200 cub. ft. per acre ; *Alnus nepalensis* at 10 years, 100 cub. ft. ; *Duabanga sonneratioides* at 6 years, 200 cub. ft., and at 10 years, 300 cub. ft. ; *Cryptomeria japonica* at 22 years, 300 cub. ft., and at 50 years, 250 cub. ft. ; *Tsuga Brunoniana* at 50 years, 150 cub. ft. ; *Cupressus torulosa* in the Nilgiris at 30 years, 200 cub. ft., *Casuarina equisetifolia* at 7 or 8 years, 200 cub. ft.; with this species the distance apart between the plants at time of formation appears to exercise considerable influence on the volume production ; a rotation of 8 to 13 years appears likely to give the best results.

It seems that pure plantations of quick growing softwood trees would prove a profitable investment when made in suitable localities. Their utilization for packing-cases, tea-boxes, pulp, ply-wood and possibly for matches wou'd probably support a considerable industry, given the conditions of accessibility, continuity of supply, and good communications. *Abies* spp. has been used in America for pencils, but the high-level forests of *Abies Webbiana* in

Darjeeling Division show only the moderate increment of 60 or 70 cub. ft. per acre per annum.

There are now 269 permanent sample plots, of which 150 are in the United Provinces, 54 in the Punjab, 33 in Bengal, 15 in the Central Provinces 13 in Madras, and 4 in the Forest Research Institute experimental garden at Dehra Dun. The extension of this work to Bombay, Assam, and Bihar is very desirable. In Bengal, nine permanent sample plots were established in the *Heritiera Formes* forests of the Sundarbans by Mr. J. R. P. Gent upon the lines of the Forest Research Institute statistical branch.

The Sal tree (Shorea robusta).—Eight strips 60 ft. wide, running in different directions, have been laid out in the experimental *Sal* forest at Thano with the object of inducing natural reproduction; each strip is being subdivided into eight sections to test the effect of soil-working, burning the dead leaves, and artificial sowing.

Sample plots have been established to determine the effect of severely thinning young crops of *Sal*, and to ascertain the stimulus afforded to the volume increment of *Sal* coppice.

It is becoming increasingly evident that *Sal* seedlings take a very long time to establish themselves unless given free access to direct overhead light, that the presence of dead leaves in or on the soil is injurious to reproduction, and that irregular or uneven-aged systems are not suited to this species.

Mr. R. S. Hole's study of the factors favouring the regeneration of *Sal*, published in the Indian Forest Record "Oecology of Sal" have done much to help us to an understanding of the difficulties.

The Silvicultural Garden.—Methods of artificial reproduction continue to be studied. Good results have been obtained by cutting back suppressed *Sal* saplings about 1½ inches thick to a length of 4 inches stem and 6 inches root and transplanting the "stumps" into the open. The germination of *Anogeissus latifolia* seeds continues to give trouble.

A start has been made in the afforestation of a grassy blank at Lachiwala in Siwaliks Division, but this is a problem whose solution will take time.

Developments in Silvicultural Systems.—The introduction of a regular system is hardly possible except where the existing forest consists chiefly of a single species. Differences in rate of growth, in demand upon light, and in requirements for reproduction render the natural regeneration of a mixed tropical forest within a limited period almost an impossibility. Something very like clear cutting, accompanied by partial or complete restocking by artificial means appears to be the only device which can be relied upon to produce an even-aged forest. Opinion throughout India is tending gradually in this direction, and the combination of field-crops with sowing tree-seeds affords such excellent opportunities for soil-working, weeding, and tending the young trees that this method of forming plantations deserves the utmost

consideration wherever local conditions are such that its introduction is practically possible. In India the physical condition of forest soil is generally such that some means of artificial aeration is necessary. Observations in the Darjeeling forests above 6,000 feet showed that the soil is everywhere more or less sour except on the site of old charcoal kilns. The three factors upon which any silvicultural system must be based are the character of the climate, of the soil, and of the tree; and every year shows an advance in our knowledge of the silviculture of Indian trees; but the requisite modifications of system to suit variations of soil and climate are as yet barely understood.

Experimental work this year has been confined to bamboos and to *Anogeissus latifolia*, whose twigs and young leaves have been found sufficiently valuable in tanning to warrant special investigation for their economic exploitation.

Of the **working-plans** published during the year Mr. Marriott's plan for the *Sal* forests of Gorakhpur is the most highly developed; the principal of concentrated regeneration in definite areas is adopted with the object of evolving an even-aged forest. Mr. Parker's plan for the Changa Manga irrigated plantations of *Moru alba* and *Dalbergia Sissoo* lays stress on the importance of tending, and points out the necessity of discovering another species to be grown as standards in view of the extent to which *Dalbergia Sissoo* is attacked by fungus Reproduction is effected by coppice and by seed naturally distributed over the area by the irrigation water. Mr. Miller's plan for the Kirwatti Teak pole area contemplates a combination of Coppice with Standards and two-storied high forest. In Burma the Wapyudaung and Bawgyo plans apply Improvement Fellings for Teak, as does Mr. Dunbar Brander's plan for the Melghat in the Central Provinces. The other published working-plans follow the systems of Coppice with Standards, Selection, or Improvement Fellings.

Owing to the demand for leather by the troops attention has been devoted to the silviculture of trees yielding tan. Several species hitherto regarded as economically insignificant have been found to possess potentialities from this aspect. *Carissa spinarum*, *Zizyphus Xylopyrus*, *Anogeissus latifolia*, *Bauhinia Vahlii*, *Phyllanthus Emblica*, *Terminalia Arjuna*, and *Lagerstroemia parviflora* have been especially brought to the front. It remains to devise systems which will yield regularly the product required by tanners without injury to the trees. Experiments with *Anogeissus latifolia* and *Cassia auriculata* are in progress. The knowledge available on the subject was summarized in a paper submitted to the Tannin Conference at Dehra Dun in August 1917.

The enhanced attention devoted to silviculture is shown by a comparison of the papers published on the subject with the lists of previous years. Each year shows an increasing number of articles, notes, and monographs In 1913-14 there were 16; in 1914-15, 24; in 1915-16, 51 in 1916-17, 65.

FORESTRY.

II.—ECONOMIC FOREST PRODUCTS

BY

R. S. PEARSON, I.F.S., F.L.S.,

Forest Economist.

Economic Uses of Deodar Timber.—The enquiry is complete with the exception that the possible outurn from various localities has yet to be ascertained : this work is now in hand. The Memoir on the subject would have been published ere this, had not work in the Forest Economic Branch very materially increased owing to the war, which also accounted for a reduction in the staff, by the services of the Assistant Forest Economist being placed at the disposal of the Military Authorities.

Utilization of Grasses for Pulp.—The enquiry to ascertain the value of certain Assam grasses for the manufacture of pulp was continued during the year. Last year the writer proceeded to Assam and demarcated plots in *Saccharum spontaneum* and *Phragmites Karka* grass areas, on the Monas River. These were again visited during the year under report in company with Mr. Hole, the Forest Botanist, to ascertain (i) the yield per acre of a uniform one year old crop, as compared with the yield of a virgin crop and (ii) to ascertain whether stems of uniform age would give better results than stems of all ages when made into paper.

The yield of green grass per acre of *Saccharum spontaneum*, when cut from a virgin crop, amounted to 21,221 lbs., on cutting the same area 9 months later the yield of green grass amounted to 11,736 lbs. per acre or roughly half the amount obtained from the first cut. The *Phragmites Karka* sample area was not again cut over, as it was nearly entirely under water, due to river flooding, while the new crop was very thin and patchy.

The cause in the reduction in yield of *Saccharum spontaneum* is attributed by Mr. Hole the new shoots being grazed by buffaloes and to a limited growing period of 9 months, while in the writer's opinion it is due to the non-burning of the area. It is of course possible that it is due to a combination of both these factors. In order to determine the annual yield, further sample plots are to be laid out by the Local Forest Officers, which will be kept under observation.

The grass cut from the *Saccharum spontaneum* sample plot was sent to the Titaghur Paper Mills Co., Ltd., together with a consignment of *Phragmites Karka* grass, to be converted, after pulping, into paper. The amount of

grass available from the *Saccharum spontaneum* sample plot was insufficient to allow of its treatment in a high pressure digester, and therefore had to be dealt with in the usual Sabai digesters. Though these tests were not conclusive, it was ascertained that an even-aged crop of *Saccharum spontaneum* stems yields a more easily bleachable pulp than that made of uneven-aged stems, while the percentage of pulp obtained is lower. *Phragmites Karka* grass gave poor results, the pulp being practically unbleachable. Until these grasses have been treated on a large scale in high pressure digesters of special design, no correct estimate can be formed of their value for paper making.

Mr. Rodger, Forest Research Officer, Burma, made a tour in the Delta, and submitted a report and map on the "Kaing" grass areas between Rangoon and Bassein in connection with the utilization of this grass for the manufacture of paper pulp.

Antiseptic Treatment of Timber.—The detailed enquiry into the value of various antiseptics and the power of absorption of such antiseptics by various timbers was continued during the year, under the following heads :—

(i) *Laboratory Experiments.*—The experimental sample plot at the Forest Research Institute, in which small stakes of twelve different species of timber are treated with various antiseptics and are embedded side by side with untreated specimens for the purpose of comparison, has been maintained and extended by the addition of specimens treated with *Concentrol.*

(ii) *Experimental treated sleepers.*—The main enquiry started in 1910, according to which a large number of sleepers of five species of timber were to be treated by four different processes, one process being taken in hand each year, was completed two years ago and the sleepers laid in the line, in different localities and kept under observation. These sleepers have been inspected by the Railway Authorities, generally in company with the writer, while those laid in the line in Burma were inspected by Mr. A. Rodger Research Officer, Burma. Some of the sleepers have now been in the line for upwards of six years and as their state is either fair to good, there is every reason to expect that the final results will be satisfactory. Many of the sleepers laid down are of conifer woods, which in an untreated state only last a little over two years, so that the treatment to date has nearly trebled the life of the timber. All sleepers referred to under these experiments were treated in Open Tanks.

A comprehensive note recording the results of these experiments has been prepared and submitted to the press for publication.

(iii) *Rüpenized sleepers.*—The sleepers of the eight species of timber referred to in last year's report, which were sent to England to be treated by the Rüpen process, were returned to India and laid down in February 1917 on the Eastern Bengal State Railway, to be kept under supervision. Some years must elapse before any opinion can be expressed as to the value of this method of treatment.

(iv) *Experiments in connection with treating timber under pressure in India.*—Considerable progress has been made in connection with treating timber under pressure in India. One of the State Railways has a scheme under consideration by which they propose to treat *Silver fir* and *Spruce* in pressure tanks. The possibility of doing so has been considerably facilitated by firms coming forward with proposals to prepare Creosote in India, while one very influential and large Company is now erecting a plant capable of dealing with upwards to 200 tons coaltar a month, from which they propose to prepare coaltar creosote. The chief difficulty at present is that the best method of treating *Silver fir* and *Spruce* has as yet to be determined. In order to do so an up-to-date experimental pressure plant is necessary, which has recently been ordered from England, and may be expected to reach India early next year. The necessary sleepers with which to carry out these experiments have been collected and are now seasoning, so that there is every hope that the results of the proposed experiments may be available in the near future.

Tanning Products.—The Tan Expert, Mr. Pilgrim arrived in India at the end of May 1916. He proceeded to Maihar shortly after his arrival in India to carry out experiments in connection with the solidification of certain tan solutions. His plant not being erected he, in the meantime, visited the Belgaum Division of the Bombay Presidency to give advice on a scheme to start a Tan Factory in that locality, and later proceeded to Burma to make preliminary enquiries into the proposed investigation to utilize Mangrove barks for the preparation of Tan Extracts.

In February 1917, Mr. Pilgrim's services were placed at the disposal of the Munitions Board, when he went to work at Maihar in collaboration with Mr. Fraymouth, manager of the "Esociet" Co. These gentlemen were given the problem of finding a substitute for *Cassia auriculata* bark. In order to assist them in doing so a variety of barks and leaves were submitted by Forest Officers, of these may be mentioned the barks of *Bauhinia Valhii, Terminalia Arjuna, Terminalia tomentosa* and *Shorea robusta*, leaves and barks of *Anogeissus latifolia, Anogeissus pendula, Phyllanthus Emblica* and the fruit of *Zizyphus xylopyra*; these having been collected and sent by the Eastern Circle, United Provinces and Divisional Forest Officers of the Balaghat and Raipur Divisions of the Central Provinces.

The results of their experiments have, as yet, not been published, though it is understood that by admixing certain of these tan products, results very similar to tanning with *Cassia auriculata* bark have been obtained.

Destructive Distillation of Wood.—The question of manufacturing "Stockholm tar," from *Pinus longifolia* wood was raised by the Conservator of Forests, Kumaon Circle and by the Working Plans Officer, Kangra Divisions, with the object of utilizing their waste wood. Experiments were carried out in the Forest Research Institute Laboratories and the sample of tar so obtained sent for valuation to interested Companies whose reports were

favourable. Field experiments were then carried out by Mr. Canning, Divisional Forest Officer, West Almora Division, who also obtained very satisfactory results. In both sets of experiments the tar was prepared in iron retorts. Further field experiments are to be carried out in the Almora forests next working season, by the Chemical Adviser in co-operation with the Deputy Conservator of Forests, to ascertain whether the tar cannot be produced in modified Charcoal Kilns. There is a very considerable demand for "Stockholm tar," especially in Calcutta, and as the process of manufacture is simple and inexpensive, there appears to be every likelihood of this industry being developed in the near future.

Physical and Mechanical Properties of certain Timbers.—(i) *Natural seasoning.*—The detailed enquiry started at the end of 1914, with the object of determining the best methods of seasoning timber is now nearing completion, and has already given valuable results, which it is hoped will be ready for publication in the near future. In collaboration with these experiments many logs have been laid down for seasoning in Rangoon and Mandalay, by the Forest Research Officer, Burma.

(ii) *Determination of warp and contraction of Pinus longifolia timber, while seasoning.*—In connection with the seasoning experiments recorded above a detailed set of experiments were carried out to determine the amount of warp and contraction which takes place, while seasoning 'Chir' timber. To determine the former factor a number of planks prepared from logs seasoned in different ways were submitted to tests in a Dalbys' Curve Tracer, which showed that planks cut from green logs and afterwards seasoned in the shade warped less than those cut from timber which had been seasoned in the log. To ascertain the amount of contraction which takes place while seasoning *Pinus longifolia* timber, an absolutely green plank was placed in a contraction recorder, which when seasoned to 13·02 per cent. of moisture, had contracted 0·27 of an inch per foot across the grain. These experiments indicate that when cutting chir sleepers it is best to do so from green logs and that at least ¼″ should be allowed for contraction on the 10″ side of a B. G. sleeper. A note incorporating details of these experiments has been sent to the press for publication.

(iii) *Seasoning Anogeissus latifolia timber.*—A seasoning experiment is in progress in the Gonda Division of the United Provinces, which has been started at the instigation of Mr. Williamson, the Conservator of Forests, to ascertain the best methods of seasoning *Anogeissus latifolia* timber, with special reference to utilizing this timber for tool handles, welding-hammer, shafts, etc. The experiment is in progress.

(iv) *Preparation of panels.*—An experiment is in progress at the Forest Research Institute to ascertain what species of timber are best suited for panelling, if correctly cut on the quarter. A number of planks have already been laid down which have been carefully cut from such species of timber as is known to contain an ornamental silver grain, the logs having been

supplied from the Chakrata and Siwaliks Divisions of the United Provinces and from the South Shan States of Burma. As soon as the planks are seasoned they will be worked up; from the preliminary cut several of the planks laid down show great promise.

(v) *Spike pulling tests.*—At the instigation of the Chief Engineer, Oudh and Rohilkhund Railway, an experiment was carried out to ascertain the best method of driving dog spikes and to determine the relative grip of screw and dog spikes. The experiments with dog spikes were carried out in the Forest Research Institute workshops. The results obtained showed that by boring a $\frac{3}{8}''$ hole right through *Cedrus deodara* sleepers, the pull required to withdraw the spike was 4,315 lbs., as against 2,770 lbs. when the spike was driven into a $\frac{5}{8}''$ hole. Spikes driven into $\frac{3}{8}''$, $\frac{1}{2}''$ and $\frac{5}{8}''$ holes bored only $1\frac{1}{2}''$ deep, gave approximately equal results, as it required between 3,700 and 3,960 lbs. to withdraw them.

In the case of dog spikes driven into $\frac{3}{8}''$, $\frac{1}{2}''$ and $\frac{5}{8}''$ holes bored right through *Sal* sleepers, the force required to draw the spikes was 5,352, 5,315 and 5,155 lbs., respectively.

The experiments with screw spikes were carried out at the Sibpur Civil Engineering College, and showed that it required 7,168, 6,966, and 5,421 lbs. to withdraw spikes screwed into $\frac{3}{8}''$, $\frac{1}{2}''$ and $\frac{5}{8}''$ holes bored right through Deodar sleepers and 10,125 lbs. to withdraw a spike screwed into a $\frac{5}{8}''$ hole bored right through a *Sal* sleeper.

Finding new Markets and uses for Timber.—(i) Bulletins dealing with the uses, outturn and prices of *Acacia arabica* and *Pterocarpus santalinus* were published during the year, while a similar publication dealing with *Duabanga sonneratioides* was sent to the press.

Gums, Resins and Oleo-resins.—(i) *Boswellia serrata gum oleo-resin.* The enquiry into the value of *Boswellia serrata* gum oleo-resin was actively prosecuted during the year. Tapping experiments were instituted by the Bombay authorities, in the North Khandesh, North Nasik and Panch Mahals Divisions, which showed that the crude 'drip' can be collected in quantity, but that when carried out on an experimental scale the cost of collection is prohibitive. The writer visited the Sheopur forests in the Gwalior State, to inspect the methods of tapping this tree as carried out by the Forest villagers, who have carried out this work for many years, on a commercial scale. The method of tapping varies little from that adopted in the Bombay experiments, though the tools employed are entirely different. The tapping of *Boswellia* in Gwalior conclusively prove that the 'drip' can be collected in large quantities and also at a cost of about Rs. 3-8 to Rs. 4 per maund, a price which is well within the commercial figure of working.

At the same time as the question of collecting the crude gum oleo-resin was under consideration, the Chemical Adviser carried out extensive and continued experiments to ascertain the best methods of separating the gum from the rosin and turpentine. This work having already been carried out

on a laboratory scale with fair success, he carried out further tests in a still capable of taking a 3 to 4 maund charge. No suitable solvent still being available, the Chemical Adviser had to improvise one out of a steam still, in which it was only possible to make fairly good bulk samples for commercial valuation; and this only after spending much otherwise unnecessary labour and money.

The enquiry is nearly completed, and as it shows great promise the results will be published as soon as possible.

(ii) *Thitsi* "*damar*."—Mr. A. Rodger, Forest Research Officer, Burma, having completed his enquiry into the uses, outturn, and properties of "Thitsi," *Melanorrhoea usitata* oleo-resin, submitted a note to the press on the subject.

(iii) *Camphor*.—The same officer submitted samples of leaves and shoots of Camphor, collected in the Southern Shan States, to the Chemical Adviser for experiment.

Fibres.—The enquiry into the possibility of placing *Helicteres Isora* fibre on the market received continued attention. Last year some 63 maunds of retted fibre were sent by Rao Bahadur Shrinivasalu Naidu to a Calcutta Rope Manufacturing firm. The report on the fibre was favourable, though the cost of hand retting in the forest proved excessive. A sample of unretted fibre was, therefore, submitted which proved unserviceable. Owing to the cost of fibres suitable for rope-making having increased, a further consignment is to be submitted while the Imperial Institute of London being interested in this fibre, a small sample has also been sent to the Director.

Woods suitable for.—(i) *Paving blocks*.—The 20,000 *Sal* paving blocks given free to the Calcutta Corporation, and which were laid down for testing, have repeatedly given trouble, due to expansion. In consequence the Calcutta Corporation have given up the idea of using wooden paving blocks. On the other hand the Executive Engineer of the Bombay Municipality, who was given *Teak* and *Xylia* paving blocks is extremely pleased with the results of this experiment, and has received sanction to extend the wood paving in Frere Road. It should be stated that these blocks were very carefully laid down and protected on the surface by a layer of tarry substance, which in its turn was coated with sand, in order to keep excessive damp from getting into the blocks.

(ii) *Bobbins*.—Samples of timber were submitted by the Forest Research Institute and the Conservator of Forests, Eastern Circle, United Provinces, to the Government School of Carpentry, Bareilly, to be made up into cotton bobbins. Several timbers appear to be eminently suitable for the purpose, amongst others may be mentioned *Adina cordifolia*, *Lagerströemia microcarpa*, *Stephegyne parvifolia*, *Populus euphratica*. The bobbins were destined to be sent to cotton spinners to be tested, but owing to the war difficulty was experienced in obtaining suitable metal pieces with which to reinforce them,

so that the tests have had to be postponed. There is little doubt that several Indian timbers will prove quite suitable for this purpose, provided they are properly seasoned before being worked up.

(iii) *Joinery.*—Various species of timber have been tested for cabinet making and carpentry at the Convalescent British Soldiers Voluntary Workshops, Mhow, which is under the direction of Mrs. Lukin, which go to prove that *Grewia tiliæfolia, Pterocarpus Marsupium, Anogeissus latifolia, Wrightia tinctoria* and *Holarrhena antidysenterica* are all suitable for the purpose. The cabinet maker in the establishment pronounced the first named timber as equal to, if not better than, Spanish Mahogany and reported that *Anogeissus latifolia* has a finer grain and figure than any known wood on the English market.

Charcoal briquettes.—At the instigation of the Divisional Forest Officer, Working Plans, Punjab, and the Conservator of Forests, Eastern Circle, United Provinces, an enquiry was started at the Forest Research Institute to ascertain whether Charcoal briquettes could be made from charcoal dust, which at present constitutes a waste product in most localities. At the same time Mr. Williamson instituted similar experiments in the Jhansi Division of his Circle. What appear to be quite satisfactory briquettes have been prepared in the Forest Research Institute workshops by using a 6 per cent. to 8 per cent. gum solution of *Bauhinia retusa* as a binding material and by subjecting the moist charcoal dust to a pressure of 4 tons per square inch, the pressure being applied by a hand hydraulic press. The binding material tried in Jhansi was loam, which resulted in the briquettes not burning properly.

Samples of briquettes made up with the above mentioned gum have been submitted to the Railways for testing, while those tested in braziers have proved excellent for the purpose. The cost of preparing such briquettes is estimated to be from 4 to 6 annas per maund.

Economic and Wood Museums.—Considerable additions have been made to both the Economic and Wood collections, while a catalogue for the former has been prepared and published.

ZOOLOGY.

I.—GENERAL ZOOLOGY AND PHYSICAL ANTHROPOLOGY

BY

N. ANNANDALE, B.A., D.Sc., F.L.S., F.A.S.B.,

Director, Zoological Survey of India.

The Zoological Survey of India was inaugurated on July 1st, 1916. Its formal constitution and the immediate reasons for its recognition as an Imperial department are set forth in the Government resolution No. 19-Museums, dated Simla, the 20th June 1916.

TOURING.

The following statement shows the tours undertaken by officers of the department in the first eight months of its official existence :—

	Days.
To Barkuda, Chilka Lake, from 14th to 23rd July, 1916	10
To Portugese India and North Canara from 24th August to 19th October, 1916	57
To Bangalore and Madras from 1st to 12th October, 1916	12
To Allahabad, Agra, Delhi and Lahore from 17th to 30th November, 1916	14
To Mutlah River from 6th to 17th December, 1916	12
To Mysore from 7th to 20th January, 1917	14
To Southern Shan States (Burma) from 8th February to 13th March, 1917	34
	153

RESEARCH.

Work of a general nature on the zoology of eastern lakes has made considerable progress in the department and investigations continue on the taxonomy of the Indian reptiles, fish, Diptera, beetles, water-bugs and spiders. Progress has also been made in anthropometrical research.

COLLECTIONS.

A large number of specimens were added to the zoological and anthropological collections.

The skeletons of mammals have been rearranged by members of the staff. The collection of musical instruments displayed in the public gallery has been rearranged by Dr. A. Meerwarth of the Petrogard Ethnographical Museum.

OFFICE OF THE DEPARTMENT.

The office of the department has been entirely reorganized.

ZOOLOGY.

II.—ECONOMIC ZOOLOGY.

Part I.—Agricultural Entomology

BY

T. BAINBRIGGE FLETCHER, R.N., F.L.S., F.E.S., F.Z.S.,

Imperial Entomologist.

I.—Work at Pusa.

Insect Pests.—Numerous observations on Insect Pests have been made during the year but these cannot be given in detail here without unduly swelling this Report. Particular attention has been paid to the pests of sugarcane and of stored grain and the more important observations are noted below :—

Cotton.—The experiments, referred to in last year's Report, were continued and tabulation of results has been taken in hand. Breeding of parasites of Cotton Bollworm (*Earias* spp.) was continued and living parasites were despatched to the Punjab in July and August 1916. Specimens of these parasites were sent to Mr. Brues, who informs us that they belong to the genus *Microbracon*, and not *Rhogas* as previously supposed.

Rice.—The lifehistory of *Nephotettix bipunctatus* was worked out. A Tubificid worm was sent in from Hmawbi, Burma, as damaging rice, but does not seem to be of regular occurrence as a pest.

Sugarcane.—Considerable attention has been paid during the year to the important subject of borers. Hitherto several different species of borers, all superficially very much alike, have been mixed together under the name of Moth Borer (*Chilo simplex*), which was supposed to attack sugarcane, *juar*, maize and rice. An attempt was made to find out whether there were really one or several species concerned. As a result the following species have been discriminated, *viz.*:—

(1) *Chilo simplex*, found in maize, *juar* and rice.

(2) *Diatræa suppressalis* (*auricilia*), found in sugarcane principally. A few only have been found in *juar* and none in maize.

(3) *Diatræa venosata* (*striatalis*) found in sugarcane and a thick variety of *juar*, and none in maize.

(4) *Diatræa* sp. There is one unidentified species found in sugarcane only. It was reported some years ago from Pabna and has recently been found at Dacca.

All the above forms had hitherto been spoken of as *Chilo simplex.*

(5) *Papua depressella*, which, as reported last year, had hitherto been known as a rootborer. But as will appear from the figures given below, it proves to be the most injurious of all the borers in the young stage of the sugarcane, its activities becoming les as the cane grows.

(6) *Scirpophaga xanthogastrella* (*auriflua*) which is one of the first borers to attack the young cane. It is active in cane throughout the year.

(7) *Sesamia inferens*, which is known to occur in maize, *juar*, sugarcane and rice and several other plants of the order Gramineæ.

This year a careful watch has been kept on the time of occurrence of all the above the borers and an attempt has been made to find out the extent of damage which they cause.

On the Pusa Farm about 4¼ acres are under thick varieties of sugarcane, *viz.*, Purple Mauritius (half-an-acre), Sathi No. 131 and Sathi No. 15 (a little less than one acre). There are also very small plots of other thick varieties, *e.g.*, Kaludie Budhan, Dacca Cane, D. 99 and Ashy Mauritius. A little more than one acre is under 21 different varieties which are classed as thin canes but some of them, *e.g.*, Meneria, might be described as of medium thickness. Of the half acre under Purple Mauritius ¼ acre was planted in November 1916; the other half of the Purple Mauritius and all the rest were planted in February 1917. The plot of Purple Mauritius has been specially grown for entomological observation and experiment and this cane has always been critically examined while the others have been superficially examined for comparison of results. All the time the sugarcane has been in the field there have been maize and *juar* growing somewhere in the Farm. The progress of the insects in sugarcane, maize and *juar* has been carefully watched and is briefly described below. Red Rot in sugarcane has necessarily come under observation and there has been a good opportunity of comparing the damage caused by it with that caused by insects.

In the middle of April the plants of the plot of Purple Mauritius planted in November were slightly ahead in growth of those of the plot planted in February, but the difference in growth did not indicate a difference of about four months in planting. The damage noticed about this time was almost wholly due to insects and the damage in the former plot was 6·3 per cent. while in the latter plot it was 2·3 per cent. Taking both the plots together, of the total damage :—

Scirpophaga xanthogastrella was responsible for 1·7 per cent.

Diatræa suppressalis for 2·3 per cent.

Gryllotalpa africana for ·1 per cent.

Red Rot for ·22 per cent.

All the affected plants were cut out and destroyed with the insects. All this time *Chilo simplex* and *Sesamia inferens* were abundant in Rabi maize and in a very small extent in Rabi *juar*.

In the second week of May the plot of Purple Mauritius planted in November was damaged to the extent of 8·9 per cent.

Papua depressella being responsible for about 1·1 per cent.

Red Rot being responsible for about 5·8 per cent.

Termites being responsible for about ·8 per cent.

Diatræa suppressalis being responsible for about ·66 per cent.

Scirpophaga xanthogastrella being responsible for about ·52 per cent.

There was one shoot damaged by *Gryllotalpa africana* and two shoots damaged apparently by Red Ants. All this time there was no difference noticeable in the growth of the plants.

In the third week of May the plot of Purple Mauritius planted in February was damaged to the extent of about 11·5 per cent. the following being responsible for the damage :—

Papua depressella about 8·1 per cent.

Red Rot about 2·27 per cent.

Diatræa suppressalis about ·7 per cent.

Termites about ·41 per cent.

Scirpophaga xanthogastrella about ·06 per cent.

There was one shoot damaged apparently by Red Ants.

All the affected plants were cut out and destroyed with the insects in both the plots.

About this time (*i.e.*, second and third weeks of May) all the other plots of sugarcane were also examined to note the extent of damage, though the affected plants were neither cut out nor critically examined to find out the agent of damage as was done with the Purple Mauritius plants. The damage was however similar in all external appearances and the agents would probably be the same as observed in the case of the Purple Mauritius.

The damage in Sathi No. 131 was 7·5 per cent.

The damage in Sathi No. 15 was 9·6 per cent.

The damage in Meneria was 10·6 per cent.

The damage in all the other 25 varieties, mostly thin, taken together was 9 per cent.

It would appear that the damage in these plots was about the same as in the Purple Mauritius plots from which all affected plants had been cut out and destroyed with the insects in April.

Throughout May *Chilo simplex* and *Sesamia inferens* were feeding in Rabi maize and to a very small extent in Rabi *juar*.

In the latter part of June the damage in the Purple Mauritius plot was about 25 per cent., the following being responsible for it :—

Red Rot about 15·4 per cent.

Papua depressella about 6 per cent.

Diatræa suppressalis about 2·2 per cent.

Scirpophaga auriflua about 1·1 per cent.

Termites about ·2 per cent.

Sesamia inferens about ·06 per cent.

A few *Diatræa venosata* were found at this time.

All affected plants were cut out and destroyed with the insects.

About this time the damage in Sathi No. 131 was about 10 per cent. As far as could be judged by external examination, about 3·5 per cent. was due to Red Rot and about 6·5 per cent. to insects.

Sathi No. 15 suffered to the extent of about 8 per cent., damage due to Red Rot being about 2·5 per cent., and that due to insects being about 5·5 per cent.

Damage in Meneria was about 14·3 per cent., Red Rot being responsible for about 11 per cent. and the insects for about 3·3 per cent.

The damage in the other (mostly thin) varieties taken together was about 7 per cent., Red Rot being responsible for about 3 per cent. and the insects for about 4 per cent.

About this time *Chilo simplex* was practically absent from maize and *juar*.

The points to note are the following :—

1. The high percentage of damage by Red Rot.
2. In the Purple Mauritius plot all affected plants had been cut out once in April and again in May. Still the amount of damage due to insects in June was greater than in any of the other plots. It is probable that Purple Mauritius is more liable to damage by insects than the other varieties. In order to test the effect of this treatment of cutting out affected shoots further experiments will be undertaken next year with a single variety. This year's experience however leads us to believe that the only insect which will be amenable to this treatment is *Scirpophaga*.

Now that the other borers can be distinguished and therefore their habits definitely studied, other methods of control will have to be found out by further study and experiment.

Other insects observed for the first time to feed under ground among sugarcane roots include :—

Alissonotum piceum grubs.

Alissonotum simile grubs.

Myllocerus blandus grubs.

A Melolonthid grub (probably *Anomala* sp.) has been observed definitely to gnaw into sugarcane stems from the side, causing a dead heart in the case of young shoots or killing the shoots and young plants. The grubs are still feeding and have not yet been reared.

Myllocerus discolor grubs have been found commonly among sugarcane roots.

The search for Coleopterous larvæ among sugarcane roots has been continued and several Chrysomelid and weevil grubs have been found which are still feeding at the time of writing this report.

As reported last year, termites have been observed to cause more damage to new shoots than to setts. Further observation confirms the view that it is only in particular soils that termites cause damage to sugarcane setts and shoots.

An experiment was undertaken in an area which is known to be very much infested by termites to find out the strength of Lead Arsenate solution which would be suitable for dipping the setts in order to protect them from termites. Lead Arsenate manufactured by the Thomsen Chemical Company was used. A strength of 1 lb. in 2 gallons of water has been found satisfactory. Even a strength of 1 lb. in 1 gallon of water can be used without any harmful effects on germination. Weaker strengths up to 1 lb. in 4 gallons water are also effective.

Maize.—The larvæ of *Heliothis obsoleta* caused a curious form of damage by boring into the tender top portion of the stem.

Fruit Flies.—Large numbers of fruit flies have been reared in the quest for parasites, but with little success. At Pusa *Chætodacus cucurbitæ*, for example, appears to be almost free of parasites, although in Southern India it is attacked by *Opius fletcheri*, which has been introduced from India into Hawaii with considerable success. *Carpomyia vesuviana*, however, is parasitized extensively and further consignments of living pupæ were sent to Italy in the endeavour to introduce these parasites there. An important paper by Professor Bezzi, on the fruit flies of the genus *Dacus* occurring in India, Burma and Ceylon, has appeared during the year, the information contained in it being largely based on material sent from Pusa. Professor Silvestri has also described several Braconid parasites of Indian fruit flies and has published a note on the occurrence of *Dacus oleæ* in India and also a description of its parasite in North-West India.

Life-histories of Insects.—In the Insectary more than 200 different lots of insects were reared and observations made on their life-history and

habits as far as possible. Of these, many were new to Science and practically none had been reared before. Several of them may be ranked among pests and may be serious occasionally: for instance, (1) a Cerambycid borer of Sannhemp. The beetle girdles the stem and deposits the egg inside the stem. The apical portion of the stem beyond the girdle dries. The grub bores inside the plant which dies. (2) A Cerambycid borer of *Phaseolus aconitifolius*. This also similarly causes the plant to die. (3) A Dermestid beetle which infested and destroyed some stored snake skins. (4) *Anobium* sp. in stored Cumin seeds and Aniseeds. It proves to be a serious pest of these seeds in store.

Investigations into the life-history and habits of the pests and other insects were continued. The important points observed with regard to some of them are noted below :—

Pea stem fly.—Three different varieties of peas were grown in the Insectary compound, some mixed with barley and others alone, for carrying on observation with regard to *Bruchus affinis*. Incidentally it was observed that those which grew alone and thinly were damaged by the stem fly while the others escaped.

Eugnamptus marginatus was kept under observation throughout the year in the Insectary as well as outside on an affected mango tree. The grubs have been observed to rest in the soil from about September to March-April. The beetles are active mostly in July and August although some may be observed before and after this period of greatest activity. Although the grubs were resting in the Insectary, one beetle was found laying eggs and cutting leaves in March, but under the climatic conditions in Bihar the grubs had no opportunity of developing as the cut leaves dried quickly ; some of these eggs were collected and reared in the Insectary, but only two attained the adult stage, one in April and one in May, and the others were resting at the time of writing the report.

Heliocopris bucephalus.—A complete cycle was obtained in the Insectary. The beetles appear in the months of June to September but mostly in July. The grubs take about a year to grow.

Attagenus piceus has been observed to take one to three years to complete its life-cycle.

Hieroglyphus banian.—In the Insectary there is a cage into which a pair was introduced in 1905. Since then they hatch out regularly every year in that cage and are fed and allowed to oviposit. The broods have been observed to extend gradually. Last year (1916) they hatched in June and the last of the adults died on 15th February 1917. Of course different batches of eggs hatched at different intervals up to August.

Some individuals of *Polytela orientalis* have been observed to rest for the whole year in the pupal stage, whilst others emerged in the first year.

Melittia eurytion, which bores and causes a swelling in the stem of *Trichosanthes dioica* and other cucurbitaceous plants in the Rains, has been observed

to rest for the remainder of the year in the larval stage inside a very stiff cocoon.

Cosmopteryx manipularis, a miner in bean leaves, has been observed to rest in the larval stage for about November to July.

The Cerambycid borer occurring in *Phaseolus aconitifolius* stem in the Rains, has been observed to rest for the remainder of the year in the larval stage.

Oides bipunctatus has been observed to have only one generation in the active season in the Rains, the rest of the year, as reported before, being passed in the egg stage.

The Eurytomine Chalcidid grub in apricot seeds probably rests for two years inside the seeds in some cases, although most come out as adults after one year. In the Insectary some grubs were observed to rest for about a year and a half and then died.

Agrypnus fuscipes.—One grub about one-third grown was collected in November 1914. It lived and grew in the Insectary since then, being fed wholly on Scarabæid and other similar grubs. It pupated and emerged in June 1917 after living for about 2½ years in the Insectary. The life-cycle therefore seems to take about three to four years.

Odontotermes assmuthi.—Colonies were established in artificial cages in July but all died by about October. In the cages buried in the Insectary compound no colony lived for the whole year.

Lampyris marginella has been found, by observation outside, to have probably one generation in the year.

Ancylolomia chrysographella hibernates in the larval stage from about November to about March-April. Then it has several broods, each cycle taking about a month. It has been observed to breed mostly among wild grasses.

Aspongopus brunneus has been observed to cause serious damage to pumpkin plants. A cycle was observed of this insect.

Massepha absolutalis and another Pyralid rolling bamboo leaves have been observed to rest in the larval stage in winter and summer.

Pyrausta machæralis has been observed to hibernate in the larval stage.

Complete cycles were observed of *Pericallia ricini*, *Amsacta moorei* (form *sara*), Hister sp., a Halticid beetle on *Anisomoles ovata*.

Pempheres affinis, the cotton stem weevil, has been observed to breed in a new foodplant, *Triumfetta* sp. (N. O. Tiliaceæ).

Polyommatus bœticus has been observed to breed in the flowers of *Butea frondosa* (*Palas*) in such large numbers as to be reckoned as a pest of these flowers.

Grain Storage Experiments. —The storage experiments were continued and the results so far obtained are briefly noted under different heads.

(i) *Wheat.*—Many of the results which promised success on the first year's trial on a small scale were upset when tried on a medium storage scale this year. But some important differences were observed in the habits of the two principal pests we have to deal with at Pusa, *i.e.*, *Calandra oryzæ* and *Rhizopertha dominica*. *Rhizopertha* cannot breed when there is free access of air, but under the reverse conditions (*e.g.*, in earthen vessels with their mouths plastered up with mud) it is capable of doing much more damage and that in a much shorter time than *Calandra oryzæ*. Air and light retard *Calandra oryzæ* and if one can take the trouble of exposing the grain to air and light at frequent intervals very little damage is done. But this is not practicable when large quantities have to be stored.

In the light of this experience wheat has been stored this year under a method of outdoor storage in granaries made entirely of straw. In this condition the grain will remain exposed to the natural changes of climate and is not expected to be susceptible to attack by *Rhizopertha*. It remains to be seen whether *Calandra oryzæ* also is retarded. If successful this method will be applicable to storage in bulk as well as in small quantities. At the same time arrangements have been made to give a satisfactory trial to the method of storage under sand.

(ii) *Rice.*—The lime treatment of husked rice has been continued and it is giving the satisfactory result reported last year.

(iii) *Pulses.*—Pulse seeds have to be protected in store against *Bruchus chinensis* which has been observed to breed in the larger varieties of Peas (*Pisum sativum*), arhar (*Cajanus indicus*), lentil, *khesari* (*Lathyrus sativus*), *mung* (*Phaseolus radiatus* and *P. mungo*), *bora* (*Vigna catjang*), *bakla* (*Vicia faba*) and gram and cause serious damage to them. Keeping the seeds covered with sand, coarse or fine, has given the best result, the seeds remaining in good condition and perfectly safe.

A species of *Bruchus* has been found to damage bean seeds in store in the same way as the above. The same method of storing under sand is applicable.

The small pea (*Pisum arvense*), as reported previously, is not liable to be damaged by *Bruchus chinensis* in store. But it is infested by *Bruchus affinis* in the field. This was dealt with in the last year's report. A system of sunning the harvested seeds has been tried this year and the result remains to be seen.

(iv) Besides the insects mentioned above, of the others which are found in stored wheat and rice (1) *Tribolium castaneum* and (2) *Tenebroides mauritanicus* are very common, but they are always found in company with *Calandra oryzæ* and *Rhizopertha dominica*.

Tribolium has been observed to occur with *Rhizopertha* more than with *Calandra* and some experiments have been undertaken to find out its status definitely.

This year there was an opportunity of following *Tenebroides mauritanicus* throughout the year and of finding out its true status. It is found commonly with *Calandra oryzæ*. It takes about a year to complete the life cycle, the adult beetles appearing and laying eggs in July-August and the rest of the year being passed in the larval stage. The adult beetles live for several months and prey upon *Calandra oryzæ* weevils. The grubs do not attack the weevils but bore wheat and rice grains. In the report for the year 1914-15, it was stated that *Tenebroides mauritanicus* on the whole played a beneficial. part and its presence in affected wheat and rice would be beneficial. Further study has shown that the good the adult beetles do by preying upon the weevils is practically of no help. The real damage to wheat is done by the weevils from July onwards and *Tenebroides mauritanicus* is present at this time only in the larval stage and does not attain the adult stage till the next year. Also the beetles do not appear in sufficiently large numbers to be of use in checking the weevils.

Insecticides.—Two insecticides were received for trial (1) Orr's Wood Preservative against termites and (2) Incosopol, a preparation from Cotton seed oil, manufactured by the Indian Cotton Oil Company of Navsari, Bombay Presidency, for trial against plant lice and such other insects. The trials have been undertaken.

Bagrada picta appeared in an experimental plot of mustard and spraying with Fishoil Resin Soap at a strength of 1 lb. in 4 gallons of water checked it entirely, killing even the adults.

Lantana Work.—This work was taken up on instructions from Government and has for its object the collection of information regarding the occurrence within the Indian Empire of any insects which may be utilized as efficient checks on the growth of *Lantana*. With this object Mr. Y. Ramachandra Rao, Entomological Assistant in Madras, has been placed on special deputation under the Imperial Entomologist, for a period of two years in the first instance, from 16th November 1916. He has commenced his work in Southern India and has made a study of the insects affecting *Lantana* in Madras, Mysore and Coorg. A large number of insects has been found to occur on *Lantana* but most of these appear to be either casuals, not confined to *Lantana* but usually very polyphagous in their habits, or of no importance as checks on *Lantana*. The insects found hitherto and which appear likely to be of use are (1) *Platyptilia pusillidactyla*, Wlk., (2) a Eucosmid moth, apparently a novelty, and (3) a Cecidomyiad fly; of these, *Platyptilia pusillidactyla*, which was one of the insects imported from Mexico into Hawaii to check *Lantana*, is already widely distributed in India and Burma, and of the other two insects further investigation is required regarding their actual value and distribution.

Bees.—The experiments with the Indian Bee (*Apis indica*) were continued. There is, however, nothing of particular interest to record.

Lac.—Emergence of Lac larvæ took place at Pusa on 20th September 1916 and 23rd June 1917. Numerous inquiries for brood-lac, etc., were dealt with during the year. No student attended the short courses in lac-culture.

Silk.—Mulberry silkworm eggs were sent to the Travancore, Mysore, Banganapalle, Bhopal, Rewah, Indore, Gwalior, Poonch (Kashmir) and Jodhpur States; to the Deputy Director of Agriculture and Land Records, Coorg; to the different silk centres of the Salvation Army and to the Tiflis Sericultural Station (Caucasus). Eri eggs were supplied to one hundred applicants and Mulberry eggs to ninety-one applicants. Eri and Mulberry seed cocoons were sent to the Director, Entomological Section, Cairo (Egypt). Mulberry cuttings and seeds were supplied to the Director of Agriculture, Burma, and to the Agricultural Officer, North-West Frontier Province, respectively. Castor and Mulberry seeds, Mulberry cuttings and samples of different kinds of silk were distributed to many inquirers. Instructions for rearing, reeling, dyeing, bleaching and spinning were given by correspondence. Univoltine mulberry silkworm eggs were sent to Shillong, Muktesar and Guindy (Madras) for cold storage and gave satisfactory results on rearing in November and March.

We at last seem to have succeeded in establishing a multivoltine hybrid race, the yield of silk of which is about 75 per cent. more than the multivoltine races generally reared in Bengal. All the eggs of the last three generations of this race have hatched like the eggs of multivoltine races and it is hoped that they will continue to do so in future. The time has perhaps come to introduce the race in the various rearing centres.

An improved Silk Twisting Machine has been made recently, on which about half-a-pound of Mulberry, Muga or Tasar reeled silk can be twisted by a boy or girl in eight hours. Some very fine silk guts were especially made for the Galvanometer magnet at the request of the Officer-in-charge, No. 18 Party (Magnetic), Survey of India.

Various experiments to improve the Mulberry silkworm races were carried on, and the second Report on these experiments is now in the press.

Illustrations.—Coloured plates illustrating the life-histories of the following insects were prepared during the year, *viz.*:—*Xylotrechus quadripes*, *Laspeyresia pseudonectis*, *Ancylolomia chrysographella*, *Scirpophaga xanthogastrella* (*auriflua*), *Argina cribraria* and *Amsacta moorei sara*. Line-drawings of about sixty insects, showing life-histories in more or less detail, and about one hundred drawings of other insects, were also prepared.

The issue of coloured plates and lantern slides has been continued, thirty new plates (including eleven of mosquitos) being printed and issued during the year.

Insect Survey.—Steady progress has been made in additions to, and arrangement of, the collection. The whole of the collection of Lepidoptera (including Micro-lepidoptera) has been overhauled, rearranged and placed in one series, so that all the information on any species or group is now available in one place. The work of rearranging the Coleoptera has been practically finished, and the same has been done in the case of the Orthoptera and part

of the Rhynchota. The identification of the collection of Diptera was undertaken by Mr. Brunetti during the year and is now in progress.

The collections continue in good order, but the difficulty of maintaining them, in boxes in open racks in a climate such as that of Pusa, is very great.

The following collections have been sent out to Specialists in the groups named and our thanks are due to them for the help afforded :—

(i) Carabidæ to Mr. H. L. Andrewes. Partly named and returned.

(ii) Curculionidæ to Dr. G. A. K. Marshall. Partly named and returned.

(iii) Anthribidæ to Dr. K. Jordan. Not yet returned.

(iv) Rutelidæ to Mr. G. J. Arrow. Named and returned.

(v) Melolonthidæ to Mr. G. J. Arrow. Partly named and returned.

(vi) Cerambycidæ to Mr. C. J. Gahan. Not yet returned.

(vii) Histeridæ to Mr. G. Lewis. Not yet returned.

(viii) Sphegidæ to Mr. Rowland E. Turner. Returned named.

(ix) Formicidæ to Dr. C. M. Wheeler. Returned named.

(x) The Apidæ named by the late Mr. C. Meade-Waldo have been returned.

(xi) Braconid parasites of *Earias* to Professor C. T. Brues. Not yet returned.

(xii) Tenthredinidæ to Mr. Rohwer. Returned named.

(xiii) *Dacus oleæ* and its parasite to Professor Silvestri. Named and descriptions published.

(xiv) Tubificid worms infesting paddy to Lieut.-Col. J. Stephenson. Examined and information communicated.

(xv) An Ichneumonid reared from cell of *Pseudagenia blanda* to Mr. C. Morley. Named and will be returned.

(xvi) Hispinæ and Cassidinæ to Mr. S. Maulik. Not yet named and returned.

(xvii) Micro-lepidoptera to Mr. E. Meyrick, F.R.S. Named and returned.

Various collections of Indian insects have been received and named and returned as far as possible. These included collections sent by the Provincial Agricultural Departments and by numerous correspondents.

II.—Work in the Provinces.

Madras.—The following are the insects which received important attention during the year :—(1) *Cirphis albistigma* on paddy in the South Arcot and Chingleput Districts. The moth trap kept at Manganallur, where the pest was expected, trapped numerous moths but the real outbreak was in the

above districts and it was not possible to do much to control the pest in this tract. The pest is being very carefully investigated. (2) *Idiocerus* sp. on mango. Spraying was done with success in the Criminal Settlement at Madanapalle and some orchardists sprayed their trees themselves in Salem. Inquiries are pouring in from different parts and campaigns are being arranged for the coming season. (3) *Spodoptera mauritia* on paddy. The moth trap tried for this proved unsuccessful. Nor did light traps show any good results. The pest was checked in two or three places by flooding, oiling the water in the fields and shaking the plants, bagging, and handpicking; people take to these methods with enthusiasm. (4) Hairy caterpillar (*Amsacta albistriga*) on groundnut received some attention. (5) Crabs in paddy nurseries and transplanted fields. Control experiments are going on. Crab pots and poisoned baits promise to show some good results. (6) *Pempheres affinis* (Cotton stem weevil). The study of its life-history is being continued persistently in spite of failures to get the eggs to hatch and the grubs to grow.

Bombay.—The *juar* crop was a failure in the Poona district, being damaged by a Cecidomyiad fly which attacks the ovaries while the head is forming, completely destroying them. A very large number of the Cecidomyiads are however parasitized by a Chalcidid. This pest has not been noted from anywhere else in India so far. There were two other moths bred out of the ear heads of standing *juar*; one was *Dichocrocis punctiferalis* and the second *Eublemma silicula*, the former being found in large numbers feeding on the unripe grain inside the heads. *Calandra oryzæ* has also been noted in the heads of standing *juar*. The maize stem fly was particularly bad on seedlings of *juar* and the same was reared from wheat seedlings sent from Sind where it was reported to have destroyed 60 per cent. of the seedlings.

Investigations were carried on in connection with the dropping of oranges and other allied fruits from the trees just at the time of approaching maturity. A fruit fly has hitherto been considered to be responsible for this damage. Last year a number of moths (*Ophideres fullonica*) were captured in the act of puncturing the fruits of Pomelo and this year no less than five different species of moths have thus been caught on oranges alone, *viz.:—Ophideres maturna, O. ancilla, O. salaminia, O. fullonica*, and *Anua coronata*. *Nyctipao macrops* was also caught in large numbers but there is no evidence to show that this punctures the fruits; it probably takes advantage of the punctures made by other moths. Fermenting sugar syrup has not been able to attract these moths. Further trials in this direction are contemplated and the only method now in use is to catch the moths with the help of a bright lantern while puncturing the fruits.

The mango crop was a failure on account of a bad attack from mango Jassids, *Idiocerus clypealis* and *I. niveosparsus*. Preliminary trials of spraying with Crude Oil Emulsion were restricted to determine the right strength at which the immature bugs could be killed. Strengths varying from 1 in 40 to 1 in 100 were tried. The mango inflorescences after being sprayed were en-

closed in muslin bags and were examined the next day and the day after. The only strength at which some bugs were killed was 1 in 40.

Some work on rats troublesome to coconut plantations was undertaken this year. Tarred tine cones were fixed to the palms round the stem. The crowns of the palms were cleared of all rats and their nests and the palms were severely isolated from other trees whose branches might touch the palms and so afford means of passage to the rats. This was perfectly successful. Check gardens which were under observation and where no precautions of any kind were taken showed that damage due to rats may go as high as 100 rupees annually for every 250 palms. There is an attempt on the part of other owners to follow this system.

The supply of seed potatoes to the cultivators having to be taken up on account of the stoppage of import of Italian seed, experiments with fumigation of home-grown potatoes were carried out to get rid of the potato worm (*Phthorimœa operculella*) which prevents the seed from being kept over from one season to another. Simple fumigation with petrol has given extremely good results and subsequent storing in gunny bags prevents all loss. Experiments with Hydrocyanic acid gas fumigation were also carried out to test its effect on germination of the tubers.

Central Provinces.—The life-history of *Stromatium barbatum*, a Cerambycid borer in orange trees, was studied at Nagpur and it was found that its life-cycle may extend over two years.

A considerable number of observations on insect pests were also made by the Field Assistant working under the Deputy Director of Agriculture, Southern Circle. The attack of *Sphenoptera gossypii*, a Buprestid borer in cotton stems, has been very considerably lessened as the result of continuous destruction of attacked plants in Berar and other cotton-growing districts.

United Provinces.—Work has been chiefly devoted to two pests: (1) Demonstrations of potato storage to avoid damage by the potato moth, *Phthorimœa operculella*. Storage in sand has been uniformly successful, and the method is being widely adopted, thousands of maunds now being stored in this way at Fatehgarh. (2) Considerable attention has also been paid to the bollworms attacking cotton. As in 1915, *Gelechia gossypiella* was a more important pest in 1916 than *Earias fabia*, and it has been shown that the most important method of carrying *Gelechia* over from one season to another is in any cotton plants left standing in the fields and in cotton seed or *kapas*.

Punjab.—From the consignments of *Rhogas* pupæ received from Pusa the parasites of *Earias* were successfully introduced at Hansi during May and June 1916. During July and August *Rhogas* was supplied in large numbers from the parasite-breeding plot to the important cotton-growing tracts of Sargodha, Lyallpur, Gurdaspur, Sialkot and Hissar; over a thousand parasite boxes were used during the season and the damage from bollworm was below normal.

In May 1917 *Rhogas* was found present in the parasite-breeding plot at Hansi and hence it has not been necessary to obtain it from Pusa.

Myllocerus blandus was a serious pest on young germinating cotton in certain tracts. As a result of observation it was determined that young maize plants will serve as a good trap for these insects and maize was recommended to be sown with cotton, the result being very satisfactory. The beetles fed entirely upon the soft juicy leaves of maize and remained hidden during the day in the whorls of leaves. The cottons remained unattacked.

Euphalerus citri has been present on all citrus plants. Preliminary investigations have been in progress during the year and the number of generations and the length of life-history are being recorded. For control a small affected garden near Lyallpur has been twice sprayed with Crude Oil Emulsion (½ pint in 4 gallons of water) and is free from the pest now.

Euproctis flava has been bred from castor, cotton, rose, peaches, pomegranates and mangoes. The caterpillars proved destructive to grapes during May and June. The washing of the bunches where the caterpillars were clustered by spraying pure water through a spraying machine proved effective. By the force of the water the caterpillars were dislodged and fell down on the ground.

The Arabian date plantations at Muzaffargarh were extensively attacked by the grubs of *Rhynchophorus ferrugineus*. After trying various other measures it was decided to build mud enclosures round the trunks of the plants and keep them filled with water day and night. The idea was that the water would soak through the tunnels to the grubs and disturb them. The result of these operations was that within 37 days 413 grubs were got out of the plants. All the plants have been saved in this way excepting two which were past all cure.

The habits and life-history of Mango Hoppers (*Idiocerus* sp.) have been studied. Spraying with fishoil soap with resin prepared by the Fisheries Department, Malabar, has given very satisfactory results.

In the spring 700 ozs. of French silkworm seed were reared in the Province. Results of 578 ozs. are available, and these produced 95 maunds 10 seers of dry cocoons.

North-West Frontier Province.—The entomological work was chiefly concerned with the spraying of orchard trees against Aphids, and there is nothing special to report.

Bihar and Orissa.—A study of the life-history and seasonal history of a Braconid parasite of *Agrotis ypsilon* was made with a view to finding out its possibilities against *Agrotis* caterpillars in the *chaur* lands of this Province. Further work was done on the life-history of *Agrotis ypsilon* in the Insectary and the question of its æstivation in the Plains was again gone into.

Arrangements were made for studying insect-affected potatoes from different parts of the Province, in order to find out if *Phthorimæa operculella*

has any important parasite. From the samples received during the year no parasite was obtained.

In the Insectary, observations were made on the life-history of twenty-five insect pests and complete life-histories of four of them were worked out during the year.

Besides dealing with a large number of minor insect pests reported from the province, a campaign was conducted against *Agrotis ypsilon* at Ghogha and Colgong with 55 Andres Maire traps with fairly satisfactory results.

Bengal.—During the year the Entomological Collector visited various places in connection with outbreaks of Rice Hispa (*Hispa armigera*), Rice Swarming Caterpillar (*Spodoptera mauritia*) and Large Brown Cricket (*Brachytrypes portentosus*) and demonstrated methods of combating them.

Spraying of Vermisapon special K for Red Spider on ganja at Nogoon (Rajshahi) was continued.

Assam.—The Entomological Assistant spent most of his time on tour combating attacks of pests, chiefly on paddy, *e.g.*, attacks of swarming caterpillars, Rice Hispa, Rice Bug, Rice Grasshopper, Rice Case worm, the Army worm, etc. He also dealt with attacks of Cotton Leaf roller, Red Cotton Bug, Greasy Surface caterpillars or Cutworms, Cane borers, the Jute semi-looper, and Red ants in various localities.

Burma.—Attention has been paid chiefly to pests of the rice plant, especially land and marine crabs of various species, and snails, both of which do serious damage in Burma. A Bulletin on the paddy pests of Burma has been written for publication.

III.—Native States.

Baroda.—Observations have been made on the life-histories of cane-borers, hairy caterpillars, tobacco stemborer (*Phthorimæa heliopa*), and cotton boll-worms.

Mysore.—*Coccus viridis.* A study of a representative collection of Green Bugs from Java, Ceylon, Seychelles and Hawaii has shown that the species is extremely variable and that the term "Green Bug" now stands for at least five distinct forms, the South Indian form being one of them. A paper on the variability of the species and a possible explanation of the phenomenon was read before the Science Congress in 1917. Anatomical studies of the South Indian form, *C. colemani*, have shown that the buccal apparatus and other structural characters have not yet been correctly described. The pest having considerably diminished in virulence, no spraying on any large scale was done but most of the infected Indian estates were visited and advice was given to deal early with the survivors from the monsoon. Experiments were conducted which show that the reappearance of the pest after the monsoon can be checked if all ants' nests are removed.

Xylotrechus quadripes.—Combative measures against this important pest of coffee consisting of scrubbing, and scrubbing with whitewashing, were conducted on nearly 4,000 plants. Results will be available in the autumn.

Mango Pests. A study of the insect enemies of the various species of mango hoppers found in Mysore has been made. A small moth whose larva is found adhering to the abdomen of *I. clypealis*, three species of bugs, one *Chrysopa*, a remarkable larva found attached to thorax of nymphs, and having the shape of a tick, a hymenopterous parasite of the eggs, a mantis, are the enemies that have been noticed.

Among other pests of mango the life-histories of a gall fly on the leaf, a small moth on the tender twigs, a Thrips on the tender leaves have been worked out.

Bruchids. Experiments against Bruchids have led to the discovery of a simple remedy. With regard to mercury, experiments show that its effect is independent of the action of light.

Amsacta spp. Work has been continued in the same centres as last year in the hope of ridding them completely of the pest. In one of these the raiyats themselves have made arrangements for handpicking, raising a voluntary subscription to pay the children for moths collected.

Castor Semilooper. (*Achæa janata*). The study of this pest has progressed satisfactorily. The discovery has been made that it is a fruit feeder and thus has led to the further discovery of the haunts of the moths.

Travancore.—*Spodoptera mauritia* occurred throughout the State as a serious major pest of the rice crop in all rice-growing seasons of the year. It is not a pest of any other crop. The kerosine process was tried and found to be effective especially when the caterpillar is young. This process was demonstrated in many places. Many ryots followed this system.

Schœnobius bipunctifer. This occurred in the month of October as a very serious pest of rice crops in South Travancore. The process of removing and destroying the affected plants, which are conspicuous by this stunted growth, goes a good long way to check the spread of the pest. The application of oil-cakes as a top-dressing in the affected field is found to be beneficial; this is also recommended. The stubbles of affected crops were examined in the beginning of April and not a single insect was found in them either as larva or as pupa.

Leptocorisa varicornis was not so very bad this year. The occurrence of this pest was reported from one Taluq where the total area of the paddy field which the pest destroyed was fifty acres. Bagging is the remedy usually recommended.

Oryctes rhinoceros appeared as a serious sporadic pest and was reported from many places. A liberal and frequent application of a mixture of sand and salt on the crown of the coconut tree was recommended.

Coconut leaf-eater. A pest belonging to the family Limacodidæ attacked the coconut trees at the beach near Trivandrum. The pest eats the green leaf blades. Nearly 3,000 trees were damaged by this insect. A Hymenopterous parasite was its natural enemy; this was bred in large numbers and let out in the affected area. The introduction of parasites had a wonderful effect in destroying the pest and saving the trees.

Cnaphalocrocis medinalis. This pest of the rice crop appeared in many places in January and was very serious in Middle Travancore. The rolled tips were beaten briskly with a stout cane. Thus the rolls were destroyed and the rollers dislodged and exposed. Then a mixture of lime and ashes in proportions of 1 : 4 was applied over the crop, after draining away the water wherever possible. The ryots approved of this process of destroying the pest.

Nymphula depunctalis appeared as a serious pest of rice crop in one locality. The kerosine process was tried and found to be very effective.

Hispa armigera did much damage to the rice crop of the south in December. The water was drained away from the attacked fields and the pest was destroyed by bagging three or four times. The result was excellent.

IV.—Other Entomological Work.

Indian Tea Association.—The Entomological Research done during the year ended June 1917 was confined to the question of mosquito blight, and consisted chiefly in the carrying out of laboratory and field experiments, in connection with the further investigation of the relations which have been found to exist between the incidence of the pest and soil conditions, and the possibility of controlling attacks by adjustment of soil conditions.

The collection of data on pests of green manure plants used in tea was continued steadily.

Advisory work, as usual, formed a considerable proportion of the work of the Department, and the districts visited by the Entomologist on tour were the Duars from Dam Dim to Kalchini, the Hailakandy Valley of Cachar, the Chargola, Longai and Halisera Valley of Sylhet, and the Mangaldai and Nowgong districts of Assam.

South Indian Planting Districts.—*Tea. Helopeltis* still continues to be troublesome, especially in the districts of Pirmad and Central Travancore. Though occasionally noticed in the Wynaad and Nilgiri Wynaad it never spreads or does any material change. Possibly in these districts climatic conditions are unfavourable to it. The worst attack occurs during the monsoon months when spraying is impossible, and experience fully shows that spray fluids are useless in the case of a bad attack, and a combination of spraying at the beginning of an attack, hand-catching, and cultural methods, are the only possible methods of control. The best means of control seems to be the pruning of large areas at such a time that the young flush will get away

before the attack of *Helopeltis* begins, and possibly spraying such areas at the very beginning of an attack if the weather is favourable.

A new pest was reported during the year from Wynaad in the shape of *Contheyla rotunda.* This did a little local damage to tea but was controlled by pruning and handpicking.

Specimens of *Terias silhetana* were reported from Mundakayam (Travancore) attacking *Albizzia* in Tea and the Tea beneath it. This again was easily controlled and a purely sporadic attack.

A few cases of Eelworm attacking seedlings in nurseries were reported. This trouble is apt to occur in old nurseries and the remedy is not to use a nursery more than once.

Coffee. Scale Insects are still troublesome and *Coccus viridis* has been generally present though not so bad as in past years. Early rains allowed the parasitic fungi to start growth early and these largely control the scale. Spraying and the systematic destruction of ants are now regular practices on the Estates, and this pest may be said to be fairly well under control. Fish Oil Resin Soap, now manufactured by the Madras Fisheries Department at Tanur, has been found the best spray material to use for all Scale Insects.

Coffee Borer has been less prevalent than in past years and this pest appears to have definite cycles.

A new pest has been reported during the year in the shape of a Tiger Beetle (*Collyris*) boring in young coffee stems in the Shevaroy District. This is of limited occurrence and a minor pest of more scientific interest than anything else at present.

Rubber. This crop continues to be free from insect pests.

ZOOLOGY.

II.—ECONOMIC ZOOLOGY.

Part II.—Forest Entomology

BY

C. F. C. BEESON, M.A., I.F.S.,

Forest Zoologist.

The writer was absent on special duty in Mesopotamia throughout the year during which Mr. B. B. Osmaston, President, Forest Research Institute and College, held charge of the office with Mr. N. C. Chatterjee, Assistant to Forest Zoologist in charge of Research work. In consequence no touring was carried out by the Forest Zoologist and no progress was made in certain items of research.

Insects of the Sal.—(*a*) The life history of *Hoplocerambyx spinicornis*, Newm. was studied under insectary conditions and breeding technique improved. An epidemic attack by this borer in the Siwalik division, U. P., resulting in the death of 7,000 sal trees was investigated by the President, and the Assistant to the Forest Zoologist, who toured in the affected forests in January—February 1917. Control measures will be attempted in 1918.

(*b*) *Aeolesthes holosericea*, Fairm. Systematic work on the early stages of this species and of associated longicorns of the genera *Xylotrechus* and *Chlorophorus* has been carried out to establish reliable identification characters. The life cycles of all species have been determined in the insectary.

(*c*) Shot hole borers. About 90 consignments of sal logs were sent in by Divisional Officers in the United Provinces, Central Provinces, and Bengal, and from these, several thousands of shot hole borers, longicorns and lepidoptera have been bred out. The identification and interpretation of this material is now in progress.

Insects of the Teak.—(*a*) *Duomitus ceramicus*, Wlk. No work in connection with this species was carried out at the Research Institute, but observation plots were laid out in Burmah, in Petsut and Mohnyin Reserves, Katha Division, in Bhamo Division, in Pyinmana Division, in Pyuchaung Reserve, South Toungoo Division. Observations in these and other localities in Burmah have been carried out by special and Divisional Officers. The results of their investigations have not yet been communicated, (*b*) No research was

undertaken with other pests of teak owing to the absence of the writer from India. Arrangements were made for the Assistant to Forest Zoologist to tour in Madras in November 1916 in connection with the defoliators of teak, but as a result of the postponement of the enquiry, these were not carried out.

Insects of the Chir.—(*a*) *Ripersia resinophila*, Green. Arrangements could not be made to visit the sample plots established in Kumaon in connection with the work on this species, and these have therefore been abandoned. Breeding work in the insectary yielded series of microlepidopterous parasites of the scale, among which are the following new species :—*Batrachedra silvatica*, Meyr., *Blastobasis transcripta*, Meyr., and *Stathmopoda adulatrix*, Meyr. In addition consignments from Chamba State, and Almora yielded *Promolactis cornigera*, Meyr. (*b*) Observations carried out in the Chir plantations of Pauri, South Garhwal, United Provinces, indicate that the trees are killed off by the successive attack of the blister fungus *Aecidium complanatum* Var. *corticola* and the weevil *Cryptorrhynchus brandisi*.

Insects of the Toon.—(*a*) The investigation into the life history of *Hypsipyla robusta* was completed and measures for its control in avenues and plantations successfully demonstrated. A bulletin has been prepared for publication. (*b*) Two new arctiid defoliators of toon were recorded. *Viz. Diacrisia obliqua*, Wlk., and *Creatonotus transiens*, Wlk.

Miscellaneous pests.—Enquiries from Divisional Officers during the year were less numerous than usual ; only 65 specimens were received for identification. The following new pests and new hosts of known pests were recorded or identified during the year.

Coleoptera.—(*a*) *Tiberioides kuwerti*, Arrow., (Passalidae) sent by the Divisional Officer, Darjeeling Division, Bengal, as a borer of *Juglans regia*.

(*b*) *Holotrichia longipennis*, Bl., (Melolonthidae) reported by the Working Plans Officer as defoliating *Quercus incana* in Kangra Division, Punjab.

(c) *Heterobostrychus aequalis*, Waterh., (Bostrichidae), reported by the Divisional Officer as boring into newly felled *Odina Wodier* timber in Tharrawaddy Division, Burmah.

(*d*) *Stromatium barbatum*, (Cerambycidae) attacked planks of *Sterculia alata* and *Pongamia glabra* in the Research Institute Museum, Dehra Dun.

(*e*) *Hoplocerambyx spinicornis*, Newm., (Cerambycidae) reported by the Divisional Officer as boring into newly felled timber of *Shorea obtusa* in North Toungoo Division, Burmah.

(*f*) *Sipalus hypocrita* Boh. (Curculionidae) reported by the Divisional Officer, Darjeeling, Bengal, as boring into newly felled timber of *Pinus Khasya*.

(*g*) *Caryoborus gonagra*, Ol. (Bruchidae), reported by the Divisional Officer, Lahore Division, Punjab, as attacking the seeds of *Prosopis juliflora*.

Lepidoptera.—*Trabala vishnu*, Lef., (Lasiocampidae) bred out by the Working Plans Officer, Kangra Division, Punjab, as a defoliator of *Quercus incana*.

Acreocercops loxias, Meyr., (Gracilariadae) bred out from leaves of *Eugenia jambolana* sent by the Superintendent of Forests, Marwar State.

Sitotroga cerealella, Ol. (Microlepidoptera) was reported by the Divisional Officer, North Thana Division, Bombay, as injurious to Bamboo seeds.

Insect Collections.—Addition of identified specimens to the collection has been small (some 40 new species) owing to the continuation of hostile action at sea. The losses include a large collection of Carabidae identified by Mr. Andrewes, which was sunk on the *Maloja*, unidentified Curculionidae on the *Arabia*, and a batch of Scorpions identified by Mr. S. Hirst, lost on the *Mongolia*. Safe arrivals include *Rutelinae*, *Cetoniinae*, and *Melolonthinae* from Mr. G. J. Arrow; *Jassidae* from Mr. W. L. Distant; *Sarcophagidae* and *Muscidae* from Mr. E. Brunetti; *Microlepidoptera* from Mr. E. Meyrick; *Lepidoptera* from Mr. T. B. Fletcher; and *Scorpionoidea* from Mr. S. Hirst.

A collection of several thousands insects made by the writer in Mesopotamia has been received.

VETERINARY SCIENCE

BY

A. LESLIE SHEATHER, B.Sc., M.R.C.V.S.,

Imperial Bacteriologist, Muktesar.

During the year in addition to minor investigations connected with the examination of specimens and serum tests for the diagnosis of Dourine, the following work was carried out at the Imperial Bacteriological Laboratory, Muktesar.

Rinderpest.—A large number of observations have been made regarding the vitality of the virus under various artificial conditions.

A report on this subject has been published by Mr. Shilston in a memoir of the Veterinary Series of Memoirs of the Department of Agriculture in India.

Further observations in connection with the same subject have been made and the results will be published as soon as possible.

With a view to economising labour and materials the use of oxalate method of preparing serum has been extended and satisfactory results are being obtained.

Anthrax and Hæmorrhagic Septicæmia.—Pressure of routine and administrative work during the early part of the year and absence of the Physiological Chemist on military duty prevented any extensive experiments in connection with these diseases being carried out. The subjects have, however, been taken up again and efforts are being made to accelerate the production of the anti-sera for these diseases. It is anticipated that labour and material will be economised.

Kumri.—A report on Kumri was submitted for publication by Dr. Macalister before he left Muktesar for military duty. It embodies an account of the disease and his work regarding the nature of the pathological changes produced.

Further research on the disease has had to be postponed for the present.

Strangles.—Pressure of other work has prevented a continuation of the experiments in connection with the immunisation of young stock at the Remount Depôts against Strangles. Anti-Strangles serum and vaccine have, however, been supplied in fairly large quantities for the treatment of the disease and have given satisfactory results.

Contagious Abortion.—Contagious abortion in cattle has been reported from some of the Military Dairies. Efforts are being made to isolate the causal organism of this disease.

Pleuro-pneumonia of goats.—During the last month or two of the year under report some experiments were carried out in connection with this disease. Failure to obtain susceptible animals for experimental purposes interrupted the work, but the subject will be taken up again when suitable animals become available.

Surra.—Some experiments in connection with the treatment of Surra have been carried out but so far without success.

Tuberculosis.—The study of strains of the tubercle bacillus isolated from cattle in this country is being continued.

Dourine.—During the past year a trypanosome infection of horses transmitted by coitus made its appearance in the Punjab and Baluchistan and evidently has a wide distribution in the horse breeding areas. Its existence is seriously interfering with the progress of horse breeding, especially in the Army Remount Department "Circles." The diagnosis of the disease in its early stages presents great difficulties. A laboratory method of examining the serum of suspected cases known as the Complement Fixation test has been successfully applied in America for the detection of infected animals, and the study of its applicability to the disease in this country has been taken up by Mr. Shilston.

A large number of tests have been carried out with promising results and it is hoped that by this means the officers of the Civil Veterinary Department and Army Remount Department may be assisted in stamping out the disease.

Johne's Disease.—The occurrence of a chronic form of enteritis has been reported from one of the Military Dairies.

Examination of specimens from three affected animals has established the fact that they were suffering from the disease known in England as Johne's disease. One animal suspected of being infected is under observation.

Reports from Veterinary Colleges and Provincial Laboratories.

(*i*) **Camel Specialist.**—Mr. Cross has written a note on the "Action of Purgatives in Camels" and his Annual Report for the year 1916-17 shows that the following reports have been sent for publication in the bulletin form by the Imperial Department of Agriculture :—

(1) A note on jhooling.

(2) Anti-fly emulsions for the protection of camels against the attacks of blood-sucking flies.

(3) Susceptibility of camels to rinderpest, hæmorrhagic septicæmia and black quarter.

(4) Feeding experiments in camels.

He is also carrying out experiments regarding Surra—

(1) the course that surra runs in the camel,

(2) the difference between camel surra and horse surra,

(3) the curative treatment of surra by means of drugs, and

(4) the preparation of a curative serum.

Civil Veterinary Department, Central Provinces.

(*ii*) The Superintendent, Mr. C. W. Wilson, enumerates the following points which are of scientific interest and worthy of record :—

(*a*) The discovery of a species of Tick (*Ornithodoros savignyi*) for the first time in Central Provinces, and says that the identification of this tick was confirmed by the Imperial Pathological Entomologist.

(*b*) Mortality of Bovines from Surra in two epidemics definitely authenticated.

(*c*) Infection of the two species of piroplasms co-existing with surra in a pony recorded for the first time in the annals of protozoology.

(*d*) Further proof of the efficiency of soamin therapy in the treatment of spirochætosis of ducks and geese was established.

MEDICAL RESEARCH.

By a resolution passed at the fifth annual meeting of the Governing Body held at Simla on the 30th of May 1916, the Scientific Advisory Board was constituted as follows :—

(1) Surgeon General Sir Pardey Lukis, K.C.S.I., K.H.S., I.M.S.

(2) Lieutenant-Colonel W. W. Clemesha, M.D., I.M.S.

(3) Major J. Cunningham, M.D., I.M.S.

(4) Major F. Norman White, C.I.E., M.D., I.M.S. (Secretary).

The investigations that have been in progress during the year concern tuberculosis ; plague ; diabetes ; the house fly ; leprosy ; osteomalacia ; and ankylostomiasis.

Tuberculosis.—Dr. Lankester's preliminary inquiries into the prevalence of this disease in India were brought to a close on the 7th of August 1916. His preliminary report was circulated to all Local Governments who were invited to express their opinions on the questions raised. Replies, received from all administrations, are now being considered by Dr. Lankester, who is engaged in drafting a final report, which is expected shortly. On its receipt the Scientific Advisory Board will address the Governing Body as to the measures which in their opinion should be taken to cope with a disease which is very widespread and the cause of much loss of life, misery and suffering.

Plague.—Since our last annual meeting Dr. Chitre has been carrying on the inquiry in the Poona district that was started by Major Kunhardt. The lines on which he has worked were fully described in our last annual report. It must be confessed that the measures employed have done little, if anything, to diminish the severity of the epidemic from which Poona has suffered, but Dr. Chitre's investigations into methods of rat destruction have yielded results that promise to be of considerable practical importance. His experiments have been well contrived and most carefully carried out.

It will be remembered that the present inquiry was started to test the tenability of Major Kunhardt's contention that it is possible to prognosticate, from a study of the plague returns of one epidemic, those places which were likely to act as foci from which infection would spread and originate the subsequent epidemic ; he believes that places infected late in the plague season are of the greatest importance in this regard. We hoped that if the hypothesis be true, energetic rat destructive measures applied to such places would result in the eradication of the disease from the area experimented on. Experience has shown us that the hypothesis has a good deal to support it though Dr. Chitre opines that grain stores and markets are also likely to act as foci of infection irrespective of the period in the plague season in which they become infected. This is likely *primâ facie.*

The failure of our plague preventive measures is in part due to the fact that the measures employed did not succeed in determining a sufficient diminution in the rat population. Phosphorus rat poisons such as the Common Sense Rat Exterminator and the Punjab Rat Exterminator were both tried and were both found very inefficient rat poisons.

The inquiry thus resolved itself into a search for a more efficient practical measure of rat destruction. Here some success has been attained. Several rat poisons have been experimented with.

(1) Barium carbonate appears to be the best rat poison yet tried. (Phosphorus poisons—sodium arsenite and sodium arsenate—were extensively experimented with).

(2) Bajri flour as a vehicle for the poison is much more attractive to rats than other substances, *e.g.*, wheat, barley, or rice flour, cheese, etc.

(3) The addition of either cheese, meat or sugar to the bait detracts from its attractiveness for rats.

Thus it would appear that not only the nature of the poison but also the manner in which it is presented to the rat, is a matter of very considerable importance.

As regards the future of the inquiry the Board have had the benefit of the opinion of Major Hutchinson, the Sanitary Commissioner, Bombay, and Major Kunhardt. The former is of opinion that the admitted failure in Poona was in a very large part due to the impossibility of getting Marwaris and other grain dealers to co-operate in rat destruction.

The Board consider that it would be most inadvisable to close down the inquiry but they consider that, for the present at any rate, Dr. Chitre should devote his entire attention to methods of rat destruction, leaving it to the local sanitary authority to apply the results with our aid and assistance, if desired.

The Board recommend that necessary sanction to the continuance of the inquiry may be accorded. Existing sanction expired on May 5th, 1917.

Hydrocyanic Acid Gas as a disinfectant.—The results of Major Liston's experiments in this connexion are briefly detailed in the attached letter.

Ankylostomiasis.—This subject is receiving increased attention. The genesis of the inquiries that are being prosecuted was referred to in our last report. Lieutenant-Colonel Clayton Lane, I.M.S., has been transferred from Darjeeling: his inquiry has thus come to an end and was closed on the 30th of April 1917.

The Association were extremely fortunate in having so experienced a helminthologist as Lieutenant-Colonel Lane at their disposal to take charge of this investigation and they take this opportunity of placing on record their appreciation of the valuable work he has carried out on their behalf.

It is to be hoped that the Local Government and the Planters' Association of Darjeeling are sufficiently impressed with the importance of the subject to maintain and extend the sanitary improvements inaugurated by Lieutenant-Colonel Lane. The expense and trouble thereby entailed will be more than compensated for by the improved health and increased efficiency of the labour forces.

Dr. Mhaskar's investigations have revealed an even greater prevalence of hookworm infestation among the cooly population of Southern India than was found among the tea garden employees of Darjeeling. The lines on which it is proposed to increase the scope of the inquiry were fully described in a recent note by the Secretary of our Board which was forwarded to the Governing Body under cover of our letter No. 52-Ak. N.I.G.-1-3, dated the 9th of January 1917. The Board consider the matter to be one of very great importance to India and they trust that whole-hearted co-operation of Local Governments will be forthcoming and will lead in the near future to active measures being taken to deal with the situation disclosed by our preliminary investigations.

Dindigul has been selected as the locale for Dr. Mhaskar's extended investigation in Madras. Local factories, the surrounding villages, and the Trichinopoly Jail will receive attention. These proposals await the sanction of the Governing Body. The approximate cost of the inquiry for twelve months exclusive of travelling allowance will amount to Rs. 15,000.

Entomology.—Mr. Awati has made good progress in his investigations into the genus *musca*. A fourth report has been received from him and is in the press.

Mr. Mitter and Mr. Swaminath are at present assisting Mr. Awati in his inquiry.

Diabetes.—Major McCay continues his investigation of diabetes in Calcutta. Much useful information is being collected especially as regards "tolerance to glucose" an important line of research, and the effects of glucose on the healthy and those predisposed to glycosuria. In those disposed to glycosuria the fat content of the blood rises with the sugar content, when the tolerance point is reached. The significance of this interesting observation is not at present understood. Time has been devoted to devising methods for the estimation of very minute quantities of sugar in urine.

Sanction to the prosecution of the investigation up to the end of the year has been accorded.

Osteomalacia.—Dr. Agnes Scott brought her investigation to a close at the end of 1916. Dr. Scott's report was published in the Indian Journal of Medical Research—July 1916, and her findings were epitomized in our last annual report.

Chaulmoogra Oil.—Lieutenant-Colonel Sir Leonard Rogers, I.M.S., has recently made what appears to be a distinct advance in the treatment of leprosy

by the intravenous injection of the so-called 'gynocardates.' A detailed chemical investigation of chaulmoogra oil is a necessary preliminary to further work in this line, and it is on such an investigation that the Indian Research Fund Association have employed Dr. Sudhamoy Ghose who is working under the general supervision of Sir Leonard Rogers in Calcutta.

A preliminary report on the results hitherto achieved is being published in the current issue of the Indian Journal of Medical Research.

Investigations in Karachi.—Major E. D. W. Grieg, I.M.S., who is at present in military employ holding the post of Pathologist, No. 37, Indian General Hospital, Karachi, is in addition to his routine duties carrying out inquiries regarding several Pathological conditions encountered among troops returning from Mesopotamia. Oriental Sore and Scurvy are at present receiving special attention. Laboratory equipment has been given him by our Association who are also meeting the contingent charges and the pay of the laboratory assistants. Interesting results are looked for.

In giving assistance to enquiries of this nature the Research Fund Association is capable of doing most useful work.

Stegomyia Survey.—In November 1913, sanction was accorded to the prosecution of a stegomyia survey in Bombay. Mr. Akula working under the direction of the Director of the Parel Laboratory was entrusted with the inquiry which still continues.

The Scientific Advisory Board recommended that this inquiry be closed with effect from June 30, 1917.

Protozoology.—Mrs. Adie continues to work in Kasauli on the life history of certain blood parasites of birds. She has submitted a report on which the Scientific Advisory Board have recommended the extension of the inquiry to the end of the present year.

The Indian Journal of Medical Research.—The journal has now completed the fourth year of its existence. It is gratifying that, in spite of the fact that the majority of our research workers are engaged in war work, the scientific articles that have been published in our pages have fallen short in neither quantity nor quality of the standard of previous years. The cost of the production has increased somewhat owing to the increased cost of materials but even now the amount spent on publication is small when compared with the importance of much of the work published.

The journal continues to receive very favourable mention in the press and we have received numerous communications all emphasizing the importance of the role the journal fills. In several instances it has been the means of bringing our workers into touch with workers in the same field in other quarters of the globe. In every sense the journal has achieved an even larger measure of success than was anticipated.

The Board wish to place on record their appreciation of the valuable services rendered by the office staff, more especially by Mr. Stuart Wilson, Chief

Superintendent, Mr. Buller-Wade in charge of the Sanitary Section, and Pundit Babu Ram, Research Fund Clerk.

Copy of a demi-official letter, dated the 18th April 1917, from Major W. Glen Liston, C.I.E., I.M.S., to Major F. Norman White, C.I.E., I.M.S., Secretary, Scientific Advisory Board, Indian Research Fund Association, Simla.

Since I submitted my last report on HCN gas, very considerable progress has been made especially in the direction of testing the use of the gas not in the laboratory but in natural conditions. Before this could be done a number of different types of machines for generating the gas had to be constructed at considerable expense. Each machine was modified in some one or other direction to make it more useful in practical application. We made, for example, two machines on trolleys the one differing from the other mainly in respect to the disposal of the tubing required for distributing the gas. Another machine was made for use on railway carriages infected with vermin. The railway companies had found it exceedingly difficult to get rid of bugs when a carriage once became infected. They had found it necessary to practically gut the whole carriage at great cost in time, labour and materials. This machine has been in use for some time at the Carriage and Wagon Workshops of the Great Indian Peninsula Railway and has been found to effectively kill bugs, cockroaches and other vermin, infesting sleeping carriages and restaurant cars.

The trolley machines referred to above were found to be inconvenient for use in large chawls or tenement buildings so that another type of machine had to be constructed consisting of two separate units carried on a hand ambulance wagon together with all tubing, chemicals, etc., required for use. With these machines, a series of trials have been made in houses.

Thus an experiment was carried out in Poona. A portion of the city was selected in which plague was present and the houses in this section were taken one by one. The construction of these houses varied very considerably from more or less *pucca* buildings to flimsy matting structures. It was not possible to completely close these houses in such a way as to prevent the escape of the gas for the majority of them had country tiled roofs. The size of the house varied considerably from fifteen thousand cubic feet to two thousand cubic feet. The arrangement of the rooms differed in each house rendering it exceedingly difficult to obtain satisfactory conditions for the diffusion of the gas in all cases. The period of fumigation, *i.e.* the period during which the room remained closed after starting the generation of the gas, varied from two to eleven hours. In some of the houses tests were made with rats placed in cages in various positions or the rats were purposely let loose in the houses and sought for afterwards. The result of this experiment in twenty-one houses showed that all rats were not killed. This was proved by the reports of the inhabitants of the houses as well as by the results obtained on the rats placed in cages. Seventy-seven per cent. of the experimental rats were killed

while the remainder remained alive. The rats which survived were those which had been placed close to the tiles in the roof, where apparently the concentration of the gas was not great enough to kill, or in deep boxes or barrels or in secluded corners where sufficient concentration of the gas had not been effected during the period the room remained closed.

While the results of these experiments on rats in houses were somewhat disappointing, we were assured by the inhabitants of the houses that the annoyance they had experienced from bugs had been removed. The effect of the gas on insects is much more marked than on vertebrates. Even among vertebrates there is a great difference in the lethal power of the gas not only on different genera but also on different individuals of the same species. Experiments showed that the construction of the gas required to surely kill rats was approximately 50 parts in one hundred-thousand. Individual rats were killed when the concentration was as low as 28 parts per one hundred thousand. Birds (sparrows were used for the experiment) were killed in a few seconds when the concentration was as low as 5 parts per one hundred-thousand.

The practical application of the gas for the destruction of bugs has yielded much more satisfactory results. The War Hospitals at Colaba and Deolali were infested with bugs; the gas was successfully used in both these institutions for killing the bugs.

While the use of the gas for destroying rats in Indian houses has not been so successful as was anticipated mainly because of the difficulty of rendering the houses "air-tight," an experiment in the hold of a ship yielded more satisfactory results. Plague rats had been found in one of the holds of the hospital ship "Sicilia." This hold adjoined the refrigerator. Previous experience with the Clayton gas, which has generally been used for disinfecting ships has shown that a ship was liable to be set on fire when the gas is introduced into holds adjoining the refrigerating plant; it was not therefore expedient to use Clayton gas in the infected hold on the "Sicilia." Hydrocyanic acid gas was suggested as an alternative. Arrangements were therefore made to generate and diffuse the gas with the machines we had available. Rats in cages were placed in different parts of the hold and after the pipes conveying the gas from the machines had been arranged and the hold had been closed, the gas was generated and blown into the hold. The hold remained closed for 24 hours. All rats were found dead when the hold was opened, many insects were also dead, but a few cockroaches were still alive behind one of the washbasins on the main deck. The capacity of the hold was fifty thousand cubic feet; the machines we had to use to do this work were designed for small rooms so that in this respect the experiment was carried out with a serious handicap; nevertheless the result was satisfactory. The experiment showed that the gas could be used with safety, that it does not damage even the most delicate articles. In view of the fact that the gas does not spoil grain or other food, that there is no danger of fire and that it has an even a more powerful destructive effect on insects than on rats, we think that there are great prospects for its successful use in the disinfection of ships. Further experiments however are required.

A much larger machine must be made than any we at present possess, and some modification must be devised for distributing the gas. The rubber pipes we at present use are heavy and costly.

The gas is in my opinion the ideal one for the disinfection of ships containing infected vermin. It will be particularly useful for the disinfection of ships placed in quarantine on account of yellow fever. The Research Fund Association, I consider, would be well advised to continue to encourage further experiments and to give a grant for the construction of a large machine suitable for the disinfection of ships.

P. S.—I propose as soon as I can find time to send you a full report of the work we have done. Much more has been accomplished than can be detailed in this letter.

APPENDIX.

Report on the principal work conducted for India at the Imperial Institute during the year ended 30th June 1917.

SCIENTIFIC AND TECHNICAL RESEARCH DEPARTMENT.

I.—SCIENTIFIC INVESTIGATIONS.

Aconites.—Owing to depletion of staff and the pressure of important work arising out of the war it has not been possible to make much progress with the research work on Indian aconites during the year.

Deodar Oil.—Two samples of Deodar oil were received from the Forest Research Institute at Dehra Dun in order that the uses and probable commercial value of the oil might be ascertained. Deodar oil is quite unknown in commerce, and the results of its preliminary examination at the Imperial Institute showed that it does not sufficiently resemble any commercial volatile oil to serve as a substitute for a known product. A complete chemical examination of the oil was therefore made in order to determine its constituents, and it was found that the two samples differred considerably in character and composition.

The results of the investigation were communicated to the Chemical Society of London by Mr. O. D. Roberts, F.I.C., and a copy of the paper is attached.

Deodar oil does not possess any marked value as a perfume, and it is uncertain whether it could be utilised as a substitute for cedar wood oil. A further supply of the oil has been requested so that further commercial enquiries can be made.

Drugs.—A sample of the stems and leaves of *Hyoscyamus muticus* grown experimentally in the Madras Presidency was received for examination. The yield of total alkaloid from the dry material was found to be 0·6 per cent. The alkaloid was readily obtained in a crystalline condition, and proved to consist of hyoscyamine. The percentage of alkaloid in this sample is higher than in previous samples of the wild plants received at the Imperial Institute from India, but it is below the amount usually present in the wild plants from Egypt and the Sudan. *H. muticus* from Egypt has proved to be a valuable source of atropine, and chemical manufacturers who were consulted by the Imperial Institute have expressed willingness to try the Indian material and a trial consignment has been requested for this purpose.

II.—TECHNICAL AND COMMERCIAL INVESTIGATIONS.

A.—Experimental Work.

Cotton.—Eleven samples of commercial Indian cottons were received from the Agricultural Adviser to the Government of India, the object being to

ascertain to what extent the improved cottons now being grown in India would be suitable for use in Lancashire. Duplicate samples were forwarded at the same time to the Manchester Cotton Association. The samples were examined at the Imperial Institute and compared with type samples of each variety. Valuations were supplied by the Manchester Cotton Association, and in the most promising cases valuations by cotton brokers in Liverpool were also obtained. All the samples were considerably superior to ordinary Indian cotton, though distinctly inferior in many cases to the cotton generally used in Lancashire. The best sample was one representing Karungani cotton from Madras, known commercially as "Company No. 2," which was fairly uniform in staple and was regarded as satisfactory by all the experts to whom it was submitted. Of the eleven samples no less than eight were regarded as saleable in Manchester, at prices ranging from 1*d.* to 2*d.* per lb. below the current value of American cotton.

Twelve samples of cotton received from the Government Experiment Farm at Akola represented the following varieties :—Rosea, Cutchica, Malvensis, Vera, Berar Jari, Saugar Jari, Bani, Buri, "K. 7," Bani×Deshi-Lahore, Bani×Rosea, and Bani×Mathio. The cottons were found to be of good quality and generally similar to a previous set of samples from Akola, mainly of the same varieties, examined at the Imperial Institute in 1915. They were valued in Liverpool at prices ranging from 6*d.* to 8¾*d.* per lb. with "middling" American cotton at 8¼*d.* per lb.

Fibres.—A sample of nettle fibre from Bengal was forwarded for examination in order to ascertain whether the material could be utilised as a flax substitute. The crude fibre, as submitted, would almost certainly be unsaleable in the United Kingdom owing to its gummy condition and the presence of bark, but if the fibre were thoroughly cleaned before shipment there seems to be no reason why it should not be used in admixture with jute or hemp for the manufacture of coarse textiles. It is, however, brittle and of irregular strength, being weaker than either flax or ramie. The clean degummed fibre was valued at £26 to £30 per ton in London (June 1916).

A sample of flax from Assam was found to be a fairly strong, medium quality warp flax, suitable for use by spinners in Ireland and comparing favourably with the medium qualities formerly received from Belgium. The sample was valued at £150 per ton in the United Kingdom under war conditions (December 1916). The subject is important, and the present is a favourable time for the development of flax growing in India.

Tobacco.—Two samples of tobacco grown in Madras from acclimatised Havana seed were found to be fairly satisfactory in composition, the percentages of nicotine and nitrogen not being excessive. When made into cigars the tobacco held fire fairly well, but the smoke was pungent and the aroma not very pleasent. The samples were not well graded, and consignments of similar character would only sell in the United Kingdom as "nondescript" tobaccos and realise a few pence per lb. under normal conditions.

Samples of tobacco were also forwarded to the Imperial Institute from Burma, with the suggestion that they would possibly be suitable for the manufacture of cigarettes and cheroots. The types of tobacco represented were Yinokkye, Seninban, Narrow Leaf, Pussa and Rungpur. All these tobaccos could be employed in the United Kingdom for cutting into pipe and cigarette tobaccos, but none of them would be regarded as suitable for making cigars or cheroots. The samples were too small for commercial valuation, but similar tobaccos would probably not be worth more than 4*d.* to 5*d.* per lb. in London. It was suggested by the Imperial Institute that the area in which these tobaccos were grown should be suitable for the production of leaf of the "bright" Virginia type, and particulars were furnished as to the cultivation of this variety.

Gums and Resins.—Four reports were furnished during the year in connection with the investigation of the resinous exudation of *Boswellia serrata* begun in 1915 at the request of the Forest Department. The results of the investigations have shown that the resin could be utilised as a substitute for common rosin in cases where solubility in alkaline solutions is not required. The Boswellia resin is soluble in alcohol and in turpentine oil, and varnishes made from it gave a fairly brilliant but rather soft coat similar to that given by good grades of ordinary rosin. The quality of the resin is about equal to that of a medium grade of American rosin.

The "gum" has also been examined with a view to ascertaining whether it could be used in calico printing and as a size in the textile industry. Exhaustive experiments were carried out at the Imperial Institute and by commercial experts, but it was found that the gum does not form suitable jellies with water and that it is not likely to be employed commercially for these purposes in the United Kingdom.

Essential Oils.—Two samples of "Sofia" (ginger-grass) oil forwarded from the Forest Research Institute at Dehra Dun were examined. The results showed that the constants of the oil were well within the rather wide range of figures previously recorded for this oil. The samples were not considered by users of ginger-grass oil to represent the highest quality of that oil. In view of the variability of the ginger-grass oil of commerce it was recommended that authentic samples should be prepared in India and forwarded to the Imperial Institute for examination and commercial valuation.

Drugs.—Two consignments of crude codeine were forwarded to the Imperial Institute from the Ghazipur Opium Factory for sale. A method of analysis was devised, and on the basis of the results obtained the consignments were sold at satisfactory prices to alkaloid manufacturers.

B.—The Technical Information Bureau.

During the year information was furnished by the Technical Information Bureau to Government Departments in India on technical and commercial subjects, and many enquiries have been answered from producers, shippers,

etc., in India, and from manufacturers, merchants and others interested in Indian produce or industries in the United Kingdom. The following are given as instances of the subjects thus dealt with.

Rice.—An enquiry has been conducted as to the desirability of introducing new and improved types of rice for cultivation on a large scale in Burma. The riee principally grown in Burma is of the round coarse-grained type, and it was desired to ascertain whether it would be advantageous to replace this to any considerable extent by the fine long-grained types. The opinions of the principal rice importers, millers and brokers in this country were obtained on this question, and detailed statements on the subject have been supplied to the Department of Agriculture. The general conclusion reached was that it would not be advisable to alter the character of the bulk of the rice exported from Burma, as there is a large and steady demand for such rice, but that the Department might distribute improved strains of the present type. Particulars were supplied as to the points to which efforts to improve the rice should be directed.

In addition, it was suggested that the Department might gradually introduce, after careful preliminary trials, new and superior types of rice, on a scale based on the market demand for such varieties, which is much more limited than that for ordinary Burma rice.

Wheat and Millet.—During the period under review the Bureau has been concerned with various aspects of the question of food supply in Great Britain, including the possibility of increasing supplies from within the Empire. In the case of India special attention has been given to cereals, including wheat and millet.

Senna.—An application was received from the Director of Agriculture in Madras for information as to the demand for Tinnevelly senna in the United Kingdom and the probable future price of the leaves. It was stated that abnormally high prices were reached in 1915, but that towards the end of 1916 the price in India had fallen to such a level as to be unremunerative to the cultivators. Enquiries were instituted as to the cause of this serious drop in prices, which was found to be largely due to the accumulation in London of stocks of inferior grades of the leaves. These are difficult to dispose of in this country, but well graded leaves of good green colour can always be sold at satisfactory prices, and it appeared from the particulars collected that the demand for such leaves is likely to be well maintained in the future. Full information as to the position was supplied, and suggestions were made regarding the production of the better grades of leaves.

Strawboard manufacture.—A request was received from the Indigenous Industries Committee of the Government of Bombay for information as to the manufacture of strawboard and the materials and plant required for the purpose. Particulars as to the process of manufacture were supplied and an estimate for suitable plant was obtained from a firm of paper mill engineers. It was pointed out that in addition to strawboard, paper of good quality could

be manufactured from straw. Specimens of paper made from straw were sent, and the suggestion was made that the manufacture of both paper and board from straw should be undertaken in India.

Beeswax.—Reference was made in last year's report to the adulteration of Indian beeswax. The Imperial Institute has drawn the attention of the Indian authorities to this matter and pointed out that the prevalence of the practice of adulterating the wax is particularly unfortunate in view of the present possibilities of the development of a considerable export trade in Indian beeswax to Russia.

In the past, the Russian supplies of beeswax were chiefly obtained from Germany, but since the outbreak of hostilities the product has been purchased from London. If a continuous supply of pure beeswax could be obtained from India it is probable that the greater part of the Russian beeswax trade would remain in British and Indian hands and that a steadily increasing industry for India would result.

The attention of some of the principal British firms importing beeswax from India has also been called to this subject, and endeavours are now being made to ensure a satisfactory supply of Indian beeswax.

In addition, the Bureau has dealt with enquiries from India regarding methods of refining beeswax and the demand for the product in the United Kingdom, and has supplied importers in the United Kingdom with the names of shippers in India.

Information on a number of other technical and commercial questions was also furnished during the year to Indian Government Departments, the India Office, and firms and individuals in the United Kingdom and India.

The subjects of these enquiries included the following :—

Foodstuffs.—Beans ; mangoes and other fruits ; sardine canning ; rice ; dari ; jaggery ; tea and coffee.

Wood Distillation.—Charcoal and charcoal briquettes ; the manufacture of wood distillation products.

Oilseeds, Oils, Fats and Waxes.—The hydrogenation (hardening) of oils ; oilseed crushing ; coconuts and copra ; poppy seed ; mowra seed ; castor seed ; sesame seed ; tea seed oil ; rape oil ; perilla oil.

Drugs.—Sandalwood oil ; thymol ; opium.

Dyestuffs.—Indigo and other indigenous dyes.

Fibres.—Hemp ; flax ; nettle fibre ; kapok ; silk.

Tanning Materials.—Mangrove bark ; tanning extracts.

Timbers.—Teak and other timbers ; blackwood furniture.

Minerals.—Bauxite ; barytes ; corundum ; graphite-schist mica-schists ; limestone ; magnesite ; manganese ; monazite ; nickel ore ; potash ; red ochre ; samarskite ; thorium and zirconium minerals.

Miscellaneous.—Machinery for cutting chank shells; toys and other native manufactures; Madras handkerchiefs; shellac; alcohol manufacture; markets for Indian goods in European countries.

Mention may also be made here of a set of maps which was prepared for the Admiralty to show graphically the localities and extent of production of oil-seeds and vegetable oils in India and other parts of the Empire.

During the year a number of reports on investigations conducted for India and several articles relating to Indian raw materials and industries were published in the "Bulletin of the Imperial Institute." Among these may be mentioned reports on Burmese Black Varnish, Lemongrass Oil, and Nettle Fibre, and articles on Sandalwood Oil, the Industrial Development of the United Provinces, and Madras Fisheries.

In addition, many of the general articles and notes published in the Bulletin contained references to Indian products.

INDIAN TRADE ENQUIRY.

In September 1916, at the request of the Secretary of State for India, the Indian Committee of the Imperial Institute undertook to enquire into the possibility of increasing the commercial and industrial utilisation of Indian raw materials in the United Kingdom and other parts of the Empire. For this purpose the Indian Committee have appointed a number of Special Committees to deal with the more important groups of Indian raw materials, to consider the results of enquiries and investigations already conducted at the Imperial Institute, and to obtain the views of leading merchants, manufacturers and other users of the raw materials of India. A list of these Committees is attached.

Considerable progress has already been made with the enquiry, and reports on trade in hides and in lac have been submitted to the Secretary of State, whilst other reports are in preparation.

COMMITTEE FOR INDIA.

Sir Charles McLeod, Chairman, East India Section, London Chamber of Commerce. (*Chairman*).

A. Yusuf Ali, Esq., late Indian Civil Service.

Sir Charles Armstrong, Messrs. Lyon, Lord & Co.

Sir Ernest Cable, Messrs. Bird & Co.

Sir Robert Carlyle, K.C.S.I., C.I.E.

Wyndham R. Dunstan, Esq., C.M.G., LL.D., F.R.S. (*ex-officio*).

Sir John Hewett, G.C.S.I., C.I.E.

The Right Hon. Lord Islington, G.C.M.G., D.S.O. (*ex-officio*).

L. J. Kershaw, Esq., C.I.E.

Sir Marshall Reid, C.I.E.

Sir James Dunlop Smith, K.C.S.I., K.C.V.O., C.I.E.

Sir George Sutherland, Messrs. Begg, Dunlop & Co.

A. J. Hedgeland, Esq., Imperial Institute. (*Secretary*).

INDIAN TRADE ENQUIRY—SPECIAL COMMITTEES.

Special Committee A.—Jute, Cotton, Wool and other Fibres.

Sir Charles McLeod. (*Chairman*).

Sir Charles Armstrong.

George Bonar, Esq., Messrs. Low & Bonar.

Sir Robert Carlyle, K.C.S.I., C.I.E.

G. C. Hodgson, Esq., Messrs. Hodgson & Co.

J. A. Hutton, Esq., Chairman, British Cotton Growing Association.

George Malcolm, Esq., Messrs. Ralli Brothers.

Professor J. A. Todd, University College, Nottingham.

Dr. S. E. Chandler, Imperial Institute (*Secretary*).

Special Committee B.—Food Grains.

Sir Marshall Reid, C.I.E. (*Chairman*).

Sir Charles Armstrong.

Sir John Hewett, G.C.S.I., C.I.E.

A. E. Humphries, Esq., President, National Association of British and Irish Millers.

The Right Hon. R. E. Prothero, M.P., President, Board of Agriculture.

Dr. T. A. Henry, Imperial Institute. (*Secretary*).

Special Committee C.—Hides and Tanning Materials.

Wyndham R. Dunstan, Esq., C.M.G., LL.D., F.R.S. (*Chairman*).

A. Yusuf Ali, Esq.

Sir W. Earnshaw Cooper, C.I.E., Messrs. Cooper, Allen & Co., Ltd.

P. H. Densham, Esq., Chairman, United Tanners' Federation of Great Britain and Ireland.

W. L. Ingle, Esq., Member of Executive Committee, United Tanners' Federation of Great Britain and Ireland.

Sir Henry Ledgard, lately President, Upper India Chamber of Commerce.

C. J. Longcroft, Esq., Messrs. D. Sassoon & Co.

E. Penton, Esq., War Office Contracts Department.

H. Brown, Esq., Imperial Institute. (*Secretary*).

Special Committee D.—Gums, Resins and Essential Oils.

A. Yusuf Ali, Esq. (*Chairman*).

Lieutenant-Colonel S. H. Godfrey, C.I.E., lately Political Agent, Baghelkhand, Central India.

Sir James Dunlop Smith, K.C.S.I., K.C.V.O., C.I.E.

Dr. T. A. Henry, Imperial Institute. (*Secretary*).

Special Committee E.—Drugs, Tobacco and Spices.

A. Yusuf Ali, Esq. (*Chairman*).

Lieutenant-Colonel S. H. Godfrey, C.I.E.

Sir James Dunlop Smith, K.C.S.I., K.C.V.O., C.I.E.

Dr. T. A. Henry, Imperial Institute. (*Secretary*).

Special Committee F.—Oil Seeds.

Sir Charles Armstrong. (*Chairman*).

Sir Marshall Reid, C.I.E.

A. Bigland, Esq., M. P., Ministry of Food.

Sir John Hewett, G.C.S.I., C.I.E.

J. W. Pearson, Esq., Chairman, Oilseed Crushers' Association.

Dr. T. A. Henry, Imperial Institute. (*Secretary*).

Special Committee G.—Timber and Paper Materials.

Sir Robert Carlyle, K.C.S.I., C.I.E. (*Chairman*).

Sir Charles McLeod.

Lawrence Mercer, Esq., C.I.E., lately President, Imperial Forest Research Institute, Dehra Dun.

Graham P. Spicer, Esq.

Dr. S. E. Chandler, Imperial Institute. (*Secretary*).

Lord Islington, Professor Dunstan and Mr. L. J. Kershaw are members *ex-officio* of the Special Committees.

List of materials received at the Imperial Institute from Government Officers in India during the year ended 30th June, 1917.

Title of Officer.	Material sent.	Number of samples.
Director of Agriculture, Madras	*Hyoscyamus muticus*	1
Director General of Commercial Intelligence, Calcutta.	Kapok	3
Director General of Commercial Intelligence, Calcutta.	Akund floss	2
Director General of Commercial Intelligence, Calcutta.	Beeswax	4
Director of Agriculture, Northern Circle, Burma.	Tepary beans	2
Director of Agriculture, Northern Circle, Burma.	Madagascar beans	10
Director of Agriculture, Northern Circle, Burma.	Native beans	2
Forest Economist, Dehra Dun	Fibre of *Helicteres Isora*	1
Deputy Director of Agriculture, Insein, Burma.	Rice and paddy	24
Director of Agriculture, Eastern Circle, United Provinces.	Jute	1
Director of Agriculture, Eastern Circle, United Provinces.	Patwa fibre	1
Director of Agriculture, Eastern Circle, United Provinces.	Dhencha fibre	1
Agricultural Adviser to Government of India	Cotton	11
Superintendent, Government Farm, Sindewahi.	Cotton	4
Fibre Expert to Government of Bengal	Buffalo horn buttons	2
Factory Superintendent, Benares Opium Agency, Ghazipur	Codeine	2
Director of Land Records and Agriculture, Assam.	Flax	1

List of Reports made by the Imperial Institute to Government Officers in India during the year ended 30th June, 1917.

Officers to whom Report was sent.	Subject of Report.
Forest Economist, Dehra Dun	Deodar oil (2 reports).
Do. do.	Boswellia gum (2 reports).
Do. do.	Boswellia resin (2 reports).
Do. do.	Sofia (ginger-grass) Oils.
Director of Agriculture, Madras	*Hyoscyamus muticus.*
Do. do.	Tobacco.
Deputy Director of Agriculture, Insein, Burma	Do.
Director of Agriculture, Central Provinces	Cotton.
Fibre Expert to Government of Bengal	Nettle Fibre.
Do. do.	Buffalo horn buttons.
Director of Land Records and Agriculture, Assam	Flax.
Director General of Commercial Intelligence, Calcutta.	Kapok.

LXIX.—THE VOLATILE OIL FROM THE WOOD OF THE INDIAN DEODAR TREE

BY

OSWALD DIGBY ROBERTS.

The deodar tree is widely distributed in Northern India, and is a native of the Western Himalaya. The timber is now being used for conversion into railway sleepers, and in the process a good deal of waste wood is produced, which, it has been suggested, might be utilised for the distillation of volatile oil, just as the waste wood from the "pencil cedars" of Florida and East Africa is employed for the manufacture of cedar wood oil.

The botanical relationships of the deodar are not yet fully worked out. Some authorities regard it as a definite species, *Cedrus Deodara*, Loud., whilst others consider it to be a varitey of *C. Libani*, Barr. The genus Cedrus includes two other well-known species or geographical varieties of *C. Libani*, namely, the Atlas cedar, *C. atlantica*, Manetti, and the Cyprus cedar, *C. brevifolia*, Elwes and Henry. The volatile oil from the wood of the Atlas cedar has been examined by Grimal (*Compt. rend.*, 1902, **135,** 582, 1057).

Deodar wood oil has been already examined by Schimmel & Co. (*Geschäftsber.*, Oct., 1914—April, 1915), who recorded its constants and isolated from it a ketone, apparently identical with that found in Atlas cedar wood oil by Grimal (*loc. cit.*), but were unable to identify the sesquiterpene, also present, with cadinene, which Grimal (*loc. cit.*) isolated from the Atlas cedar oil he examined.

The two samples of deodar oil examined by the author were received at the Imperial Institute from the Forest Economist to the Government of India in 1914 and 1915 respectively.

Both samples of oil were of reddish-brown colour, and possessed a characteristic balsamic odour. They had the following constants :

	(I).	(II).
D_{15}^{15}	0·9549	0·9756
α_D^{22} in a 100 mm. tube	+52°16′	+34°6′
n_D^{21}	1·5195	1·5225
Acid value	5·6	4·5
Ester value	19·3	4·9
" after acetylation	30·8	34·4
Solubility in 90 per cent. alcohol	Not soluble in 20 or less volumes.	Miscible in all proportions

The following fractions were obtained when the oils were distilled under atmospheric pressure :

Fraction.	Boiling point.		Sample (I).	Sample (II).
1	230—260°	Per cent.	16	8
		D_{15}^{15}	0·9605	0·9472
		a_D^{22}	+40°12′	+29°0′
2	260—270°	Per cent.	25	16
		D_{15}^{15}	0·9467	0·9439
		a_D^{22}	+53°15′	+27°44′
3	270—280°	Per cent.	47	24
		D_{15}^{15}	0·9466	0·9482
		a_D^{22}	+41°12′	+26°18′
4	280—310°	Per cent.	10	35
		D_{15}^{15}	0·9419	0·9634
		a_D^{22}	..	+18°33′
Residue		Per cent	2	17
		D_{15}^{15}	..	1·0821

Description of Fractions.

Fraction 1 was of pale yellow colour and contained a ketone the odour of which characterised the original oil. With ferric chloride this fraction gave a blood-red coloration due to the presence of a phenol (see p. 794). Fractions 2 and 3 were bright yellow in colour, somewhat viscous, and possessed very little odour. In the case of the first sample, fraction 4, which was dark brown and very viscous, deposited some crystals on keeping ; these proved to be stearic acid, resulting probably from the decomposition of an ester.

Isolation of a Ketone, $C_9H_{14}O$.

This ketone, which does not combine with alkali sulphites, was isolated from fraction 1 by means of its semicarbazone, which after several crystallisations from alcohol was obtained in colourless, glistening leaflets melting at 163—164° :

0·1895 gave 0·4282 CO_2 and 0·1492 H_2O. C=61·6 ; H=8·7.

0·1396 ,, 0·3159 CO_2 ,, 0·1100 H_2O. C=61·7 ; H=8·7.

$C_{10}H_{17}ON_3$ requires C=61·5 ; H=8·7 per cent.

The ketone in fraction 1 reacted with hydroxylamine to form an oxime which could not be obtained in a solid condition, but combined with bromine, producing a solid dibromo-oxime melting at about 130°. The ketone has an odour recalling that of amyl acetate, and is probably *p*-methyl-Δ^3-tetrahydroacetophenone. The latter substance has not been identified previously as

a constituent of a volatile oil, but is obtained by the oxidation of β-terpineol (Stephan and Helle, *Ber.*, 1902, **35,** 2151). According to these authors the odour of this ketone somewhat resembles that of amyl acetate ; the ketone has b. p. 68·5—70°/4 mm., D^{15} 0·9435, n_D^{15} 1·4742, and its semicarbazone forms colourless leaflets melting at about 160°.

Decomposition of the semicarbazone by dilute sulphuric acid and distillation with steam yielded, however, as chief product, not the original ketone, but a fraction boiling at 222—224° (uncorr.), which had n_D^{20} 1·4965, and furnished a semicarbazone melting at 204—205°. This appeared to be *p*-tolyl methyl ketone, and this conclusion was confirmed by the production from it of bromoform boiling at 151°, and *p*-toluic acid melting at 178—179°, by oxidation with a 4 per cent. alkaline bromine solution. The acid obtained did not depress the melting point of pure *p*-toluic acid, and was oxidised by potassium permanganate to terephthalic acid, leaving no doubt as to its identity with *p*-toluic acid. This ketone is apparently identical with that isolated by Grimal from oil of *Cedrus atlantica* (*loc. cit.*), which gave a semicarbazone (m. p. 159—160°) and a dibromo-oxime (m. p. 132—133°).

Isolation of a Phenol.

Having removed from the original oil by treatment with dilute sodium carbonate solution a small quantity of free acids which appeared to consist mainly of acetic acid, the phenols were separated from the oil with a 5 per cent. solution of sodium hydroxide, the amount obtained corresponding with 0·4 per cent. on the original oil. The substance possessed a sweet, phenolic odour, and was almost insoluble in water. It produced a deep blood-red coloration with ferric chloride in alcoholic solution, and yielded a benzoyl derivative, which crystallised from dilute alcohol in small, slender needles melting at 70°. No phenol with these properties appears to have been recorded as a constituent of a volatile oil. As the second sample of oil contained less than 0·1 per cent. of this phenol, further investigation was not possible.

Hexoic, Heptoic, and Stearic Acids resulting from the Hydrolysis of the Oil.

After having freed the original oil from acids and phenols, it was digested on the water-bath for two hours with excess of *N*/2-alcoholic potassium hydroxide. The product was shaken with a large excess of brine, and the clear aqueous liquid separated from the oily portion and submitted to steam distillation in order to remove the alcohol together with traces of oil. The residue from the above distillation was acidified with dilute sulphuric acid, steam again passed in, and the distillate collected in three fractions. In fractions 1 and 2 insoluble acids had separated, but fraction 3 contained very little acid ; the odour of fraction 1 resembled that of *n*-hexoic acid. Silver salt

prepared from these fractions by precipitation gave the following percentages of silver :

Fraction 1 : 0·1106 gave 0·0540 Ag. Ag=48·8.
$C_6H_{11}O_2Ag$ requires Ag=48·4 per cent.

Fraction 2 : 0·0612 gave 0·0278 Ag. Ag=45·5.
$C_7H_{13}O_2Ag$ requires Ag=45·5 per cent.

Hence these volatile acids would appear to consist of a mixture of hexoic and heptoic acids.

The oily residue remaining after the saponification, and precipitated by the brine, was semi-solid owing to the presence of sodium salts of higher fatty acids. It was shaken repeatedly with successive quantities of water rendered slightly alkaline with potassium hydroxide, and from the combined aqueous extracts the acids were liberated by dilute sulphuric acid. The crude product was dissolved in hot alcohol, which on cooling deposited stearic acid in crystalline laminæ melting at 71°. The acid was converted into the silver salt, of which 0·02119 gave 0·0585 Ag ; Ag=27·60. (Stearic acid melts at 69·3—71·5° according to different investigators, and silver stearate contains Ag=27·62 per cent.) The neutralised mother liquor from which the stearic acid had separated was submitted to fractional precipitation with alcoholic silver nitrate. The silver salt was in each case reprecipitated to free it from impurities which were present in appreciable quantity. The various fractions gave the following results on analysis :

1st precipitation :	0·1308 gave	0·0361 Ag.	Ag=27·59 per cent.
2nd ,,	0·1416 ,,	0·0390 Ag.	Ag=27·54 ,, ,,
3rd ,,	0·1270 ,,	0·0335 Ag.	Ag=26·37 ,, ,,
4th ,,	0·1950 ,,	0·0520 Ag.	Ag=26·66 ,, ,,

The decreased percentages of silver obtained in fractions 3 and 4 are due probably to contamination of the silver salt with non-acid impurities rather than to the presence of some other acid.

The second sample of the deodar oil contained a relatively small percentage of esters, and no esters of stearic acid were found.

Isolation of a Sesquiterpene.

The principal constituents of this oil are sesquiterpenes, which appear to be associated with a variable amount of sesquiterpene alcohols, a high proportion of the latter being indicated by a marked increase in the gravity of the oil, a greater solubility in 90 per cent. alcohol, and also a correspondingly higher acetylation value (compare constants of samples I and II on p. 792). Having freed the original oil from free and combined acids and phenols by treatment with alcoholic potassium hydroxide, it was distilled under atmospheric pressure, and the portion boiling between 250° and 280°, which constituted the bulk of the oil, collected separately. After prolonged treatment with sodium

with many distillations under diminished pressure, the greater part of the product was found to consist of a fraction which boiled at 151—153°/19 mm. or 262—265° (uncorr.) atmospheric pressure. This fraction was a colourless, mobile liquid, and had D^{15}_{15} 0·9319, a^{23}_{D} + 16°51′, n^{23}_{D} 1·5150. (An otherwise similar fraction obtained from the first sample of oil had a^{22}_{D} + 58°34′). Its solution in glacial acetic acid produced a characteristic colour reaction with concentrated sulphuric acid similar to that of cadinene :

0·1883 gave 0·6036 CO_2 and 0·1949 H_2O. C=87·4 ; H=11·5.
$C_{15}H_{24}$ requires C=88·2 ; H=11·7 per cent.

As it was not, apparently, entirely free from oxygen, the fraction was distilled over phosphoric oxide in order to determine whether this would produce any alteration in its physical properties. The product which boiled at the same temperature now had D^{15}_{15} 0·9276, a^{0}_{D} + 14°36′, n^{21}_{D} 1·5170, and 0·1363 gave 0·4399 CO_2, and 0·1424 H_2O. C=88·0 ; H=11·6 per cent.

Attempts to prepare solid derivatives of this sesquiterpene were unsuccessful. Hydrogen chloride was absorbed with avidity when passed into a cooled ethereal solution, and when after keeping for some days the ether was evaporated, most of the combined hydrogen chloride was thereby expelled. The residue distilled at 145—155°/10 mm., and the colourless oil thus obtained had D^{15}_{15} 0·956 and contained only 4·9 per cent. of chlorine :

$C_{15}H_{24}$,HCl requires HCl=15·17 per cent.

Summary.

The composition of the volatile oil from the wood of *Cedrus Deodara*, Loud., as indicated by the results of this investigation, is as follows :

	Per cent.
A *ketone*, $C_9H_{14}O$, probably methyl-Δ^3-*p*-tetrahydroacetophenone	about 2
A *phenol* undetermined	from 0·07 to 0·4
Esters of hexoic, heptoic, and stearic acids	from 3 to 12
Sesquiterpenes : consisting chiefly of a *d*-sesquiterpene of variable rotation	from 50 to 70

Sesquiterpene Alcohols.—These appeared to constitute the remainder of the oil, associated with high boiling, viscous, decomposition products.

SCIENTIFIC AND TECHNICAL RESEARCH DEPARTMENT.
IMPERIAL INSTITUTE, (*Received, July 20th, 1916.*)

LIST OF PUBLICATIONS.

Agricultural Chemistry.

ANNETT, H. E. . . Some results of experiments on the palm sugar industry (*Agri. Jour. of India, Vol. xii, p. 144*).

" " . . Some experiments in the improvement of the date palm sugar industry (*Agri. Jour. of India, Vol. xii, p. 442*).

BARNES, J. H. & ARJAN SINGH. Chalybeate water from tube wells in the Punjab: their significance to the municipal engineer and to the manufacturer (*Agri. Jour. of India, Special Indian Science Congress number, 1917, p. 43*).

BARNES, J. H. . . The after ripening of cane, chemical changes which take place after cutting (*Agri. Jour. of India, Vol. xii, p. 200*).

BARNES, J. H. & BARKAT ALI. Alkali soils, some biochemical factors in their reclamation (*Agri. Jour. of India, Vol. xii, p. 368*).

DAVIS, W. A. . . The phosphate depletion of the soils of Bihar; its effect on the quality and yield of crops and the contingent risks of malnutrition and endemic disease in cattle and man (*Agri. Jour. of India, Special Indian Science Congress number, 1917, p. 77*).

" " . . The phosphate depletion of soils of Bihar and its contingent risks of malnutrition and endemic disease; a warning (*Agri. Jour. of India, Vol. xii, p. 181*).

FINLOW, R. S. & MACLEAN, K. Water Hyacinth (*Eichornia crassipes*) (*Bull. No. 71 of the Agri. Research Instt., Pusa*).

SEN, J. . . . The influence of the presence of calcium carbonate in the determination of available phosphoric acid in soils by Dyer's method (*Agri. Jour. of India, Vol. xii, p. 258*).

" " . . . Some observations on the occurrence of infertility under trees (*Agri. Jour. of India, Vol. xii, p. 390*).

" " . . . The composition of some Indian feeding stuffs (*Bull. No. 70, Agri. Research Instt., Pusa*).

VENKATARAMAN, T. S. & KRISHNAMURTHI ROW Study of the sucrose variation in successive cane joints as they attain maturity with special reference to the death of leaves (*Agri. Jour. of India, Special Indian Science Congress number, 1917, p. 117*).

VISWANATH, B. . .	Some enzymes of germinating red gram (*Cajanus indicus*) (*Agri. Jour. of India, Special Indian Science Congress number, 1917, p. 109*).
WARTH, F. J. . .	Mandalay milk supply (*Burma Bull. No. 15, 1917*).

Forest Chemistry.

SINGH, PURAN . .	Note on Kakrasinghi as a tanning material.
,, ,, . .	Note on the Nilgiris Wattles.
,, ,, . .	Note on the fruits of *Zizyphus Xylopyra* as a tanning material.
,, ,, . .	Note on the Products of *Frenela Rhomboidea*.

Astronomy.

EVERSHED, J. . .	New measures of radial motion in sunspots (Kodaikanal Bull. No. 51).
EVERSHED, J. and EVERSHED, M. A.	Results of prominence observations (Kodaikanal Memoirs, Vol. i, Pt. II).
EVERSHED, J. . . .	The solar prominence of 1916 May 26 (Kodaikanal Bull. No. 55).
GALE AND WHITNEY .	On the pole effect in a calcium arc. Astrophysical Journal 43, 161, 1916.
ROYDS, T. . .	Summary of prominence observations for the first half of 1916 (Kodaikanal Bull. No. 52).
,, . .	The displacements of the nickel and titanium lines in the sun and arc (Kodaikanal Bull. No. 53).
,, . .	The cause of the so-called pole effect in the electric arc (Kodaikanal Bull. No. 54).
,, . .	Summary of prominence observations for the second half of 1916 (Kodaikanal Bull. No. 56).
STRUTT, R. J. . .	Note on the uprush of gases in the solar prominences. Monthly Notices of the Royal Astronomical Society 77, 59, 1916.
WHITNEY, W. T. .	The pole effect in a calcium arc. Astrophysical Journal 44, 65, 1916.

The following papers deal with anomalous dispersion in the sun :—

ALBRECHT, S. . .	Observatory 39, 314, 1916.
,, ,, . .	Astrophysical Journal 49, 1, 1916.
EVERSHED, J. . .	Observatory 39, 432, 1916.
ST. JOHN, C. E. .	Observatory 39, 462, 1916.
,, ,, .	Astrophysical Journal 49, 311, 1916.

Meteorology.

BEMMELEN, DR. W. VAN.	Results of Registering-Balloon Ascents at Batavia. *Batavia, K. Mag. en Met. Observatorium, Verhandelingen No. 4, 8vo. pp. lvii + 109, 1916.*
DINES, W. H. . .	Circulation and temperature of the atmosphere. *Monthly Weather Review, Washington, 43, 1915 (551-556).*
" " . .	The local circulation of the atmosphere. *Monthly Weather Review, Washington, 44, 1916, pp. 182-186.*
GRIFFITH TAYLOR .	Initial Investigations in the Upper Air of Australia. *Commonwealth Bureau of Meteorology, Bull. No. 13, Melbourne, 1916.*
HUMPHREYS, W. J. . .	Wind velocity and elevation. *Monthly Weather Review, Washington, 44, 1916 (14-17).*
MCADIE, A. . .	Aerography, the science of the structure of the atmosphere. *New York, Geog. Rev., 1, 1916 (266-273), and Sci. Amer. Sup., New York, 83, 1916 (20-21).*
MARVIN, C. F. . .	Marine meteorology and the general circulation of the atmosphere. *Washington, Proc. Nat. Acad. Sci., 2, 1916 (421-424).*
PICKERING, PROF. W. H.	Effects of hurricanes on the upper air currents. *Monthly Weather Review, Washington, 43, 1915 (496-497).*
SHAW, SIR NAPIER .	Illusions of the upper air. A review of progress in Meteorological theory in England since 1866. *Nature, London 97, 1916 (191-194; 210-213).*
SWANN, W. F. G. .	On the ionization of the upper atmosphere. *Terrestrial Magnetism, Washington, D. C., 21, 1916 (1-8).*

Terrestrial Magnetism.

MOOS, N. A. F. . .	Report of the Director, Bombay and Alibag Observatories, for the year ending December 31, 1916.

Geology.

Bibliography for 1916.

BROWN, J. COGGIN .	A Descriptive Catalogue of the meteorites comprised in the collection of the Geological Survey of India, Calcutta (on August 1st, 1914). (*Mem., Geol., Surv. India, Vol. xliii, pt. 2.*)

BROWN, J. COGGIN . A Note on the Iron-ore Deposits of Twinnge, Northern Shan States. (*Rec., Geol. Surv. India, Vol. xlvii, pp. 137-141.*)

" " . Contributions to the Geology of the Province of Yunnan in Western China : 5. Geology of parts of the Salween and Mekong valleys. (*Rec., Geol. Surv. India, Vol. xlvii, pp. 205-266.*)

BURRARD, COL. SIR SIDNEY G. The Plains of Northern India and their relationship to the Himalaya Mountains. (*Journ. Proc., As. Soc. Bengal, New Series, Vol. xii, No. 2, pp. lxxxi-xcviii.*)

COTTER, G. DE P. . Contents and Index of the Memoirs of the Geological Survey of India, Vols. xxi-xxxv, 1884-1911.

" " . Corrective Note on the Age of the Tertiary of Java (*Rec., Geol. Surv. India, Vol. xlvii, p. 79.*)

DAS-GUPTA, H. C. . Notes on some fish teeth from the Tertiary beds of Western India (Abstract). (*Journ. Proc., As. Soc. Bengal, New Series, Vol. xii, No. 2, p. cxxi.*)

DOUVILLE, PROF. HENRI Le Cretace et l'Eocene du Tibet Central. (*Pal. Ind., N. S., Vol. v, mem. No. 3.*)

FERMOR, L. L. AND FOX, C. S. The Deccan trap flows of Linga, Chhindwara district, Central Provinces. (*Rec., Geol. Surv. India, Vol. xlvii, pp. 81-136.*)

HAYDEN, H. H. . . Notes on the Geology of Chitral, Gilgit and the Pamirs. (*Rec., Geol. Surv. India, Vol. xlv, pp. 271-335.*)

" " . . General Report of the Geological Survey of India for the year 1915. (*Rec., Geol. Surv. India, Vol. xlvii, pp. 1-41.*)

" " . . Mineral Production of India during 1915. (*Rec., Geol. Surv. India, Vol. xlvii, pp. 144-195.*)

HOFFMANN, J. D. . The Bawdwin Mines, *Mining Magazine, Vol. xiv, pp. 139-146.*

HOLDEN, MISS RUTH . A Fossil wood from Burma. (*Rec., Geol. Surv. India, Vol. xlvii, pp. 267-272.*)

LOVEMAN, M. H. . The Geology of the Bawdwin Mines, Burma. (*Bull. Amer. Inst. Mining Engineers, No. 120, December, 1916, pp. 2119-2143.*)

PILGRIM, C. E. AND COTTER, G. DE P. Some newly discovered Eocene mammals from Burma. (*Rec., Geol. Surv. India, Vol. xlvii, pp. 42-77.*)

PORRO, DR. CESARE . Geology of the country near Ngahlaingdwin, Minbu district, Burma (with geological map by C. Porro and R. Lewer and Appendix by G. de P. Cotter). (*Rec., Geol. Surv. India, Vol. xlv, pp. 249-270.*)

REED, F. R. COWPER . Supplementary Memoir on New Ordovician and Silurian fossils from the Northern Shan States. (*Pal. Ind., N. S., Vol. vi, Mem. No. 1.*)

SEN GUPTA, KIRAN K. . On the Hypersthenization of Monoclinic Pyroxenes (Abstract). (*Journ. Proc., As. Soc. Bengal, New Series, Vol. xii, No. 2, pp. cxxi-cxxiii.*)

" " . On the Correlation of Augite-diorite and dolerite (Abstract). (*Journ. Proc., As. Soc. Bengal, New Series, Vol. xii, No. 2, p. cxxiii.*)

VREDENBURG, ERNEST W. Flemingostrea, an eastern group of Upper Cretaceous and Eocene Ostreidæ; with descriptions of two new species. (*Rec., Geol. Surv. India, Vol. xlvii, pp. 196-203.*)

WALKER, H. . . . The Visuni and Ekh Khera Aerolites. (*Rec., Geol. Surv. India, Vol. xlvii, pp. 273-279.*)

WARTH, H. . . . Chemical composition of the Red Marl of the Salt Range, Punjab. (*Rec., Geol. Surv. India, Vol. xlvii, p. 78.*)

Botanical Survey.

ANONYMOUS . . . *Eria tomentosa* Hook f. (*Bot. Mag., Vol. xii, tab. 8662) from Indo-China.*

" . . . *Pandanus furcatus* Roxb. (*Bot. Mag., Vol. xii, tab. 8671) from India.*

" . . . *Dendrobium Palpebrae* Lindl. (*Bot. Mag., Vol. xii, tab. 8683) from Burma.*

" . . . *Amorphophallus Kerrii* N. E. Brown. (*Bot. Mag., Vol. xiii, tab. 8692.*)

BAYLEY BALFOUR . . A few new species of *Primula*. (*Notes from Roy. Bot. Gard. Edinburgh, Vol. ix, No. xliii. March 1916*).

" " . . A few new species of *Rhododendron*. (*Notes from Roy. Bot. Gard. Edinburgh, Vol. ix, Nos. xliv-xlv. June 1916*).

BLATTER, E. . . . The Palms of British India and Ceylon indigenous and introduced Part XVI. (*Journ. Bomb. Nat. Hist. Soc., Vol. xxiv, No. 3*).

" " . . *Cocoineae.* (*Journ. Bomb. Nat. Hist. Soc., Vol. xxiv, No. 4*).

BLATTER, E. . . *Lepidocaryinae (Journ. Bomb. Nat. Hist. Soc. Vol. xxv, No. 1).*

BOWER, F. O. . . Studies in the Phylogeny of the Filicales. (*Ann. Bot., Vol. xxxi, No. Cxxi, Jan. 1917, p. 1.*)

BURKILL, I. H. . . Note on the Pollination of flowers in India. (*Journ. and Proceedings Asc. Soc. Bengal, Vol. xii, 1916, pp. 239-265.*)

" " . . A note on the Terai Forests between the Gandak and the Teesta. (*Journ. and Proceedings Asc. Soc. Bengal, xii, 1916, pp. 267-272.*)

CHIBBER, H. M. . A List of the Natural Orders and the Genera of Bombay Plants with Derivations of the Names Part II. (*Journ. Bomb. Nat. Hist. Soc., Vol. xxiv, Nos. 3-4.*)

CRAIB, W. G. . . Contributions to the Flora of Siam. (*Kew Bull., No. 10, 1916, p. 259.*)

DALLIMORE, W. . The Asiatic Pines. (*Kew Bull., No. 10, 1916, p. 254.*)

DASTUR, J. F. . . Spraying for Ripe-rot of the Plantain fruit. (*Tropical Agriculturist, Oct. 1916, p. 231, from Agric. Journ. of India.*)

GAMBLE, J. S. . . Description of new species in "Decades Kewenses" (*Kew Bull. Nos. 5 and 8, 1916.*)

GHOSE, S. L. . . Occurrence of a fern *Peranema cyatheoides* at a comparatively low altitude. (*Journ. Bomb. Nat. Hist. Soc., Vol. xxiv, No. 3, p. 616.*)

GRUNNING, G. . . *Euphoribiaceæ—Porantheroideæ et Recinocarpoideæ (Euphorbiaceæ—Stenolobeæ) (Das Pflanzenreich, lviii, IV, 1913.)*

HUTCHINSON, J. . Description of new species in "Decades Kewensis" (*Kew Bull. No. 2, 1916*).

ISABEL, MISS AND McCLATCHIE. Observations on the root system of *Impatiens Roylei* Wall. (*Journ. Linn. Soc., Vol. xliii, No. 294.*)

KRAUZLIN, F. . . *Cannacæ (Das Pflanzenreich, lvi, 77 pp.).*

LACAITA, C. C. . . Plants collected in Sikkim including the Kalimpong District. (*Journ. Linn. Soc., Vol. xliii, No. 293, December 1916.*)

MOLLIARD, M. . . Modifications sexuelles chez le *Picea morinda.*

NARASIMHAM, M. J. . Malformations in *Casuarina.* (*Journ. Bomb. Nat. Hist. Soc., Vol. xxiv, No. 3, p. 615.*)

PEARSON, R. S. .	Rosha grass *Cymbopogon Martinii* Stapf. (*Indian Forest Records, Vol. v, pt. vii.*)
RAMASWAMI, M. S. .	A new species of *Tephrosia falciformis* Ramaswami. (*Journ. and Proceedings Asc. Soc. Bengal, Vol. xii, 1916, No. 3.*)
RANGACHARI, K. .	Notes on an undescribed species of *Cynodon Cynodon Barberi* Rangachari. (*Journ. Bomb. Nat Hist. Soc., Vol. xxiv, No. 4, p. 486.*)
ROLFE, R. A. . .	*Cirrhopetalum concinnum* Hook. f. var. purpurea (*Bot. Mag. 1916, Vol. xii, tab. 8668.*)
SCOTT, M. B. . .	Description of new species in Decades Kewenses (*Kew Bull., No. 2, 1916.*)
SPRAGUE, T. A. .	*Clematis Meyeniana* (*Kew Bull., No. ii, 1916*).
STAPF, C. . . .	*Cycas Thoursii* (*Kew Bull., No. I, 1916, p. 1*).
,, ,, . . .	*Pandanus furcatus* Roxb. (*Bot. Mag. 1916, Vol. xii, tab. 8671.*)
,, ,, . . .	Description of new species in "Decades Kewenses." (*Kew Bull. No. 2, 1916.*)
VENKATA RAO, M. K. .	Some diseases on trees in Mysore caused by a species of *Phytophthora*. (*Journ. Bomb. Nat. Hist. Soc., Vol. xxiv., No. 3, p. 615.*)
WILLIS J. C. . .	The Evolution of species in Ceylon with reference to the dying out of species. (*Ann. Bot., Vol. xxx, No. cxvii. Jan. 1916, p. 1.*)
WORSDELL, W. C. .	The Morphology of the Monocotyledonous Embryo and of that of the grass in particular. (*Ann. Bot., Vol. xxx, No. cxx, Oct. 1916, p. 509.*)

Agricultural Botany.

BARBER, C. A. . .	The classification of indigenous Indian canes. (*Agr. Jour. of India, Vol. xi, 1916, p. 371.*)
BURKILL, I. H. . .	Notes on the pollination of flowers in India—Note No. 8, Miscellanea. (*Jour. and Proc. Asiatic Society of Bengal, New Series, Vol. xii, 1916, p. 239.*)
BURMA WATER HYACINTH ACT I, 1917.	*Agr. Jour. of India, Vol. xii, 1917, p. 333.*
BURNS, W. . . .	Annual report of the Experimental work (done outside the Ganeshkhind Botanical Garden) by the Economic Botanist and his staff. Poona, 1916.

BURNS, W. . . . Annual Report of the Experimental work in the Ganeshkhind Botanical Garden, 1915-16. Poona, 1916.

BURNS, W. AND OTHERS. Some wild fodder plants of the Bombay Presidency. (*Bulletin No. 78, Department of Agriculture, Bombay, 1916.*)

CHIBBER, H. M. . Models to illustrate segregation and combination of Mendelian characters. (*Agr. Jour. of India, Special Congress No., 1916.*)

CLARKE, G. . . . Improved sugarcane in the United Provinces. (*Agr. Jour. of India, Vol. xi, 1916, p. 243.*)

CLOUSTON, D. . . . The improvement of cotton cultivation in the Central Provinces studied from an economic point of view. (*Agr. Jour. of India, Special Congress No., 1917.*)

EVANS, G. . . . Improved varieties of wheat for the Central Provinces. (*Agr. and Co-operative Gazette, Vol. xiii, Nos. 1 and 2, 1917.*)

FINLOW, R. S. . . The improvement of the jute crop by pure line selection. (*Agr. Jour. of India, Vol. xii, 1917, p. 283.*)

FINLOW, R. S. AND McLEAN, K. Water hyacinth (*Eichornia crassipes*) and its value as a fertilizer. (*Agr. Jour. of India, Vol. xii, 1917, p. 419.*)

GANGULEE, N. . . Studies of leguminous plants. (*Poona Agr. College Mag., Vol. xiii, 1917, p. 141.*)

GRAHAM, R. J. D. . Pollination and cross-fertilization in the Juar plant. (*Mem. Dept. of Agr. in India, (Bot. Series), Vol. viii, 1916, p. 201.*)

HECTOR, G. B. . . Observations on the inheritance of anthocyan pigment in paddy varieties. (*Mem. Dept. of Agr. in India, (Bot. Series), Vol. viii, No. 2, 1916, p. 89.*)

" " . . The improvement of the rice crop in Bengal by pure line selection. (*Agr. Jour. of India, Vol. xii, 1917, p. 280.*)

HILSON, G. R. . . A simple method of selfing cotton. (*Year Book, Madras Agricultural Department, 1917, p. 54.*)

HOWARD, A. . . Soil Aeration in Agriculture. (*Bull. No. 61, Agr. Reserac h Institute, Pusa, 1916.*)

HOWARD, A. AND HOWARD, G. L. C. Third report on the improvement of Indigo in Bihar. (*Bull. 67, Agr. Research Institute, Pusa, 1916.*)

HOWARD, A. AND HOWARD, G. L. C. The economic significance of the root-development of agricultural crops. (*Agr. Jour. of India, Special Congress No., 1917.*)

HOWARD, G. L. C. . The wheats of Baluchistan, Khorasan and the Kurram valley. (*Mem. Dept. of Agr. in India, (Bot. Series), Vol. viii, 1916, p. 1.*)

HUNTER, C. . The aerating system of *Vicia Faba*. (*Annals of Botany, xxix, p. 627.*)

" " . . Some observations on the effect of soil aeration on plant growth. (*Proceedings University of Durham Philosophical Society, Vol. iv, p. 183.*)

JOSHI, P. G. . . Points regarding the selection of grafts for planting. (*Poona Agr. Coll. Mag., Vol. viii, 1916, p. 105.*)

KOTTUR, G. L. . . Influence of environment on the colour of the wheat grain. (*Poona Agr. Coll. Mag., Vol. viii, 1917, p. 183.*)

MANN, H. H. . . Fodder crops of Western India. (*Bulletin No. 77, Dept. of Agr., Bombay, 1916.*)

PARNELL, F. R. . A mill for the quantitative husking of paddy in small lots. (*Yearbook, Madras Agr. Dept., 1917, p. 52.*)

RANGA ACHARYA, R. . An undescribed *Cynodon* grass allied to the common *Cynodon dactylon*. Two species of *Panicum* of the paddy fields till now considered as one. (*Yearbook, Dept. of Agr., Madras, 1917.*)

SHRIVASTAVA, K. P. . An account of the genus *Capsicum* grown in the Central Provinces and Berar. (*Bull. No. 5, Dept. of Agr., C. P. and Berar, 1916.*)

TADULINGAM, C. . An account of a tour made in the Nellore District in connection with the grazing question in the months of January and February 1916. (*Yearbook, Madras Agr. Dept., 1917.*)

TUNSTALL, A. C. . Some observations on tea seedlings. (*Q. Jour. Indian Tea Association, 1916, p. 103.*)

" " . Tea Roots. (*Bull. No. 7, Indian Tea Association, 1916.*)

VAGHOLKAR, B. P. . Notes on the propagation of the *ber* tree in East Khandesh. (*Poona Agr. Coll. Mag., 1916, p. 124.*)

VENKATARAMAN, T. S. A study of the arrowing (flowering) in the sugarcane with special reference to selfing and crossing operations. (*Agr. Jour. of India, Special Congress No. 1917.*)

Forest Botany.

BENSKIN, E. . . Damage by Frost (*Ind. For. xliii, 290*).

COLEMAN, L. C. . Spike Disease of Sandal (*Bull. 3, Mycol. Ser. Dept. of Agric., Mysore State, Bangalore, 1917.*)

COOMBS, G. O. . Note on Urginea indica, Kunth (*Ind. For. xliii, 80.*)

COVENTRY, B. O. . Correlation between light and soil requirements of a species (*Ind. For. xliii, 186.*)

HAINES, H. H. . New species of Acacia. (*Ind. For. xliii, 88.*)

" " . . Forests of northern Champaran. (*Ind. For. xliii, 245.*)

" " . . Descriptive List of Trees, Shrubs and Economic Herbs of the Southern Circle, Central Provinces. (*Allahabad, 1916.*)

HOLE, R. S. . . Chief Factors influencing the development of Sal seedlings. (*Ind. For. xlii, 335.*)

" " . . New Indian Species of Forest Importance. (*Ind. For. xliii, 132.*)

" " . . Indian Species of Iseilema. (*Agric. Journ. of India, Special Ind. Science Congress Number, 1917, p. 125.*)

" " . . Oecology of Sal, Part II, Seedling Reproduction. (*Ind. For. Records, Vol. v, 4.*)

" " . . Oecology of Sal, Part III, Soil-aeration. (*Ind. For. Records, Vol. v, 4.*)

HOWARD, S. H. . Distribution of Sal in Ramnagar Forest Division. (*Ind. For. xliii, 55.*)

RAITT, W. . . Collection of Savannah Grasses for pulping experiments. (*Ind. For. xlii, 500.*)

RAO, M. RAMA. . Extraordinary phenomenon in a Mahogany Seedling. (*Ind. For. xlii, 555.*)

SHIVAPURI, S. S. . Butea frondosa evolving simple leaf. (*Ind. For. xliii, 28.*)

STEVENS, E. R. . Effect of drought on the Sal in the Ramnagar Forest Division. (*Ind. For. xlii, 366.*)

TIREMAN, H. . . Lantana in the forests of Coorg. (*Ind. For. xlii, 385.*)

TRAFFORD, F. . Grass under Trees. (*Ind. For. xlii, 545.*)

WITT, D. O. . . Descriptive List of Trees, Shrubs, Climbers and Economic Herbs of Northern and Berar Circles of Central Provinces. (*Allahabad, 1916.*)

Mycology.

AJREKAR, S. L. . . The mode of infection and prevention of the Smut disease of Sugarcane. (*Agri. Journ. of India, xi, 288, 1916.*)

Annual Reports of the Agricultural Reserach Institute, Pusa, and of Provincial Departments of Agriculture.

ANSTEAD, R. D. . Notes. (*Planters' Chronicle, xi and xii, 1916-17.*)

BUTLER, E. J. . . The dissemination of parasitic fungi and International Legislation. (*Mem. Dept. of Agric., Bot. Ser. ix, No. i, 1917.*)

COLEMAN, L. C. . . Spike disease of Sandal. (*Bull. Dept. of Agric., Mysore, Myc. Ser. iii, 1917.*)

DASTUR, J. F. . . Phytophthora sp. on Hevea brasiliensis. (*Mem. Dept. of Agric., India, Bot. Ser. viii, No. 5, 1916.*)

" " . . Phytophthora on Vinca rosea (*Mem. Dept. of Agric., India, Bot. Ser. viii, No. 6, 1916.*)

DASTUR, J. E. . . Conditions influencing the distribution of Potato blight in India. (*Agric. Journ. India, Special Science Congress Number, 1917.*)

McRAE, W. . . Notes on South Indian Fungi. (*Year Book, Madras Agric. Dept., 1917.*)

SUNDARARAMAN, S. . Short smut on Cholam (Andropogon Sorghum). (*Year Book, Madras Agric. Dept., 1917.*)

TUNSTALL, A. C. . Notes. (*Quarterly Journ., Ind. Tea. Assoc., 1916-17.*)

Agricultural Bacteriology.

BARNES, J. H., AND BARKAT ALI. Alkali Soils; some biochemical factors in their reclamation. *Agri. Journ. of India, July, 1917.*

EVANS, G. . . . Annual Report of the Deputy Director of Agriculture, Central Provinces, Northern Circle, for 1915-16.

HUTCHINSON, C. M. . Annual Report of the Imperial Agricultural Bacteriologist for 1915-16.

" " . The Importance of Bacterial action in Indigo manufacture.

" " . A Bacterial Disease of Wheat in the Punjab. *Mem. of the Dept. of Agri. in India, Bact. Ser., Vol. i, No. 7.*

" " . The Pebrine Disease of Silkworms in India. *Bul. No. 75 of the Agri. Res. Inst. Pusa.*

Sylviculture.

ALLEN, C. W. . . Teak taungya plantations in the Henzada-Maubin Division. (*Ind. For. xlii, 533.*)

BARRINGTON A. H. M Working Plan for the Bawgyo Working Circle, Mandalay Forest Division, Southern Circle, Upper Burma.

BENSKIN, E . . Damage by Frost. (*Ind. For. xliii, 290.*)

BIJAY KUMAR BHATTACHARJ'. Sundri (*Heritiera minor*) (*Ind. For. xliii, 21.*)

,, ,, Note on Golpatta (*Ind. For. xlii, 509.*)

BOURNE, R. . . A classification of Thinnings and Increment Fellings. (*Ind. For. xlii, 368.*)

BUTTERWICK, A. J. . Demarcation of Forest Reserves in Burma. (*Ind. For. xlii, 502.*)

CARR, J. . . . Working Plan for the mixed forests of the Balaghat Division, Centra' Provinces.

CLIFFORD, J. D. . The formation of Teak taungya plantations in Burma. (*Ind. For. xliii, 117.*)

COVENTRY, B. O. . Correlation between the Light and Soil requirements of a species for its natural regeneration. (*Ind. For. xl ii, 186.*

DODGSON, J. . . Progress of silvicultural works in North Kanara Division. (*Ind. For. xliii, 15.*)

DODSWORTH, O. A. . A note on *Sa* timber operations in Singhbhum. (*Ind. For. x'iii, 122.*)

DUNBAR-BRANDER, A. A. Working Plan for the Melghat Forest Division, Central Provinces.

GOVINDA MENON, K. . A possible cause of "Spike" in Sandal. (*Ind. For. xlii, 476.*)

GRIEVE, J. W. A. . Note on Forest Policy in Burma. (*Ind. For. xl'i, 444.*)

HAINES, H. H. . . Possible use of Phenyle in Nurseries. (*Ind. For. xliii, 17.*)

,, ,, . The forests of Northern Champaran. (*Ind. For. xliii, 245.*)

,, ,, . . Treatment ot bamboo-flowered areas in Angul. (*Ind. For. xlii, 374.*)

HART, G. S. . . Note on a tour of Inspection in the Chamba State.

,, ,, . . Note on a tour of Inspection in Darjeeling and Kurseong Forest Divisions, Bengal.

HART, G. S.	.	Note on a tour of Inspection in Kumaon Forest Circle, United Provinces.
" "	.	Note on a tour of Inspection in Sundarbans Forest Division, Bengal.
HILL, M.	.	Note on an enquiry by the Government of India into the relation between Forests and Atmospheric and Soil Moisture in India.
HODGSON, E. M.	.	Working Plan for Gokak Range forests of the Belgaum District, Bombay Presidency.
HOLE, R. S.	.	Chief Factors influencing the Development of *Sal* Seedlings. (*Ind. For. xlii, 335.*)
" "	.	Oecology of Sal, *Parts ii and ii*.
HOWARD, S. H.	.	The Distribution of the Sal in the Ramnagar Forest Div'sion. (*Ind. For. xliii, 55.*)
HTAO HAI	.	Commercial *versus* quasi-commercial departmental Teak extraction in Burma. (*Ind. For. xliii, 111.*)
JEFFERY, G. R.	.	Working Plan for the Wapyudaung Working Circle, Rubi Mines Division, Southern Circle, Upper Burma.
JERRAM, M. R. K.	.	Forestry in Mesopotamia. (*Ind. For. xliii, 85.*)
MACKENZIE, J. M. D.		Fuel and Bamboo Plantations in the Sittang Delta of the Pegu District, Lower Burma. (*Ind. For. xliii 2.*)
MARJORIBANKS, G. E.	.	Progress of the Casuarina plantations in Kanara. (*Ind. For. xliii, 128.*)
MACMILLAN, H. R.	.	Notes on the Prospect of Working the hard-wood forests of Burma. *Ind. For. xlii, 481.*)
MALCOLM, C. A.	.	Some problems in connection with Grazing in the Central Provinces. (*Ind. For. xliii, 10.*)
MARRIOTT, R. G.	.	Working Plan for the forests of the Gorakhpur Division, Eastern Circle, United Provinces.
MARSDEN, EDWARD	.	Statistics compiled in the Silviculturist's office during 1915-16.
MILLER, W. A.	.	Complete Volume Analysis of Teak from Kirwati Jungles. *Ind. For. xlii, 420.*)
" "	.	Working Plan for the Bhagwati Blocks viii, ix, and xx of the Kanara Northern Division, Bombay Presidency.
" "	.	Working Plan for the Kirwatti Teak Pole Area of the Kanara Eastern Divis'on, Bombay Presidency.

MILWARD, R. C. .	Among the Eucalypts.
NIXON, A. B. . .	A start in the departmental supply of rubber boxes in Mergui. (*Ind. For. xliii, 205.*)
PARKER, R. N. . .	Working Plan for the Changa Manga Plantation, Lahore Division, Punjab.
PARNELL, R. . .	Cleanings, Improvement Fellings, and Thinnings (*Ind. For. xlii, 516.*)
PATTERSON, C. B. .	Cleanings, Thinnings, and Improvement Fellings. (*Ind. For. xliii, 202.*)
RAMA RAO, M. . .	Growth of Soymida febrifuga in Trichinopoly. (*Ind. For. xliii, 19.*)
" " . .	An extraordinary phenomenon in a Mahogany seedling. (*Ind. For. xlii, 555.*)
REGO, J. D. . .	Regeneration of Teak in the Mundgod pole forests of North Kanara. (*Ind. For. xliii, 197.*)
RODGER, A. . .	Forest Growth on Old Shifting Hill Cultivation. (*Ind. For. xlii, 499.*)
SEN GUPTA, B. C. .	Sal at its extreme Eastern limit . (*Ind. For. xliii, 225.*)
SHRINIVASULU NAYADU, S.	A Note on the Afforestation of the Telan-Kher Hill, Nagpur. (*Ind. For. xlii, 392.*)
SMYTHIES, E. A. .	Possibilities of development in the Himalayan Coniferous forests. (*Ind. For. xliii, 165.*)
STEVENS, E. R. . . .	Effect of Drought on the Sal in the Ramnagar Forest Division. (*Ind. For. xlii, 366.*)
SUNDARAM AIYAR, M. R.	Concentrated regeneration of Teak. (*Ind. For. xliii, 199.*)
TIREMAN, H.	Lantana in the Forests of Coorg. (*Ind. For. xlii, 385.*)
TRAFFORD, F. . .	Grass under Trees. (*Ind. For. xlii, 545.*)
TREVOR, C. G. . .	The natural regeneration of Coniferous woods. (*Ind. For. xliii, 257.*)
" " . .	Cleanings, Improvement Fellings, and Thinnings. (*Ind. For. xlii, 515.*)
" " . .	Increment Fellings. (*Ind. For. xlii, 554.*)
TROUP, R. S. . .	The work of the Forest Department in India.
WALKER, H. C. . .	The issue of timber licenses in Burma. (*Ind. For. xliii, 70.*)
" " . .	Forest Reservation in Burma. (*Ind. For. xliii, 172.*)

WATSON, H. W. A. . Forest Reservation in Burma. (*Ind. For. xlii, 439.*)

WHITEHEAD, T. A. . Note on Red Sanders.

WIMBUSH, A. . . Coppice with Standards. (*Ind. For. xliii, 230.*)

WRIGHT, H. L. . . Some Impressions of the Kulu forests. (*Ind. For. xliii, 75.*)

Forest Products.

CHAPIN, E. S. . . Natural Dyestuffs, a revival of long abandoned methods. (*Scientific American cxv, 410 and 411.*)

COLLINS, S. H. . . A Portable Plant for the Distillation of Wood. (*Journ. Soc. Chemical Industry, xxxvi, 68-70.*)

COOMBS, G. O. . . Note on *Urginea indica* found in Bundelkhand and adjoining Central India States (*Ind. For., xliii, 80-85*).

HUNT, G. M. . . Preservative Treatment of Farm Timbers (*U. S. Dept. of Agriculture, Farmers' Bulletin No. 744*).

KANCHIRA, R. . . The Uses of Formosan Trees (*Ind. For., xlii, 410-420*).

KELLEHER, D. . . Paper Making Process (*Journ. Soc. Chemical Industry, xxxv, 1256*).

KIRWAN, J. D. M. . Note on Babul *Acacia arabica* (*In the Press*).

KRESSMANN, F. W. . Ethyl Alcohol from Wood, the Process, its Development and Requirements (*U. S. Dept. of Agri. For. Service of 1915*).

PALMER, R. C. AND BOCHMER, H. R. Extraction of Rosin from Wood by means of Petroleum (*Oil and Color Trades Journ., li, 305-306*).

PEARSON, R. S. . . The commercial Side of Forest Work in India (*Ind. For. xlii, 527-533*).

" " . . The Recent Industrial and Economic Development of Indian Forest Products (*Journ. Royal Soc. of Arts, lxv, 487-493*).

" " . . A further Note on the Antiseptic Treatment of Timbers, recording results obtained from past experiments (*In the Press*).

" " . . Note on Kokan or Lampatia Timber, *Dalbergia sonneratioides*. (*In the Press*).

PRASAD, MATHURA . Note on *Urginea indica* (*Ind. For., xliii, 291-292*).

RAITT, W. . . Note on the Collection of Savannah Grasses for Pulping Experiments. (*Ind. For., xlii, 500 and 501*).

RODGER, A. . . Note on Thitsi (*In the Press*).

WHITEHEAD, T. A. . Note on Red Sanders, *Pterocarpus santalinus* (*For. Bulletin No. 34 of 1917*).

General Zoology.

The following list of books, memoirs, etc., that have a direct bearing on Indian Zoology and were published during the year 1916-17 has been drawn up as usual by Dr. B. L. Chaudhuri.

GENERAL.

ANNANDALE, N. . . Zoological results of a tour in the Far East. Introduction. (*Mem. Asiat. Soc. Bengal, vi, I.*)

HORNELL, J. . . Report to the Government of Baroda on the Marine Zoology of Okhamandal in Kattiawar. *Part II.*

KEMP, S. W. . . Notes on the Fauna of the Matlah river in the Gangetic delta. (*Rec. Md. Mus., xiii, 233.*)

PRASAD, B. . . The seasonal conditions governing the pond life in the Punjab. (*Jour. and Proc. Asiat. Soc. Bengal, (N. S.) xii, 141.*)

WOODLAND, W. N. F. . Recent experimental enquiries concerning the so-called "Renal Portal" system. (*Ibid., (N. S.) xiii, 180.*)

PROTOZOA.

BHATIA, B. L. . . Notes on the Ciliate Protozoa of Lahore. (*Rec. Ind. Mus., xii, 177.*)

CHATTERJEA, G. C. . Notes on a free living *Amœba* of a new species. (*Proc. Ind. Assoc. Cult. Sc., iii, 1.*)

MELLO, F. DE . . Quelques considérations sur les affinités zoologiques du genre "*Hœmocystidium*," avec description d'une espèce nouvelle. (*An. Sci. Faculd. Med. Porto, iii, 5.*)

" " . . Hematozoaires et Pseudo-hematozoaires de l'Inde Portugaise. (*Ibid., No. 3.*)

SHORD, H. E. . . Notes on two Hæmogregarines of Cold-blooded Vertebrates. (*Ind. Journ. Med. Research, iv, 402.*)

PORIFERA.

DENDY, A. . . . Report on the Calcareous sponges at Okhamandal in Kattiawar collected in 1905-06. (*Rep. Gov. Baroda Mar. Zool. Kattiawar, ii, 79.*)

DENDY, A. . . Report on the Non-Calcareous sponges at Okhamandal in Kattiawar, collected in 1905-06. (*Rep. Gov. Baroda Mar. Zool. Kattiawar, ii, 93.*)

CŒLENTERATA.

ANNANDALE, N. . . Zoological results of a tour in the Far East. Hydrozoa and Ctenophora. (*Mem. Asiat. Soc. Bengal, vi, 101.*)

BROWNE, E. T. . . Some Jelly-Fishes from Okhamandal in Kattiawar. (*Rep. Govt. Baroda Mar. Zool. Kattiawar, iii, 151.*)

THORNELY, L. R. . Report on the Hydroida of Okhamandal in Kattiawar. (*Rep. Govt. Baroda Mar. Zool. Kattiawar, iii, 147.*)

HELMINTHES.

LANE, C. . . . *Bunostomum kashinathi* and the Ancylostomidæ. (*Ind. Journ. Med. Research, iv, 414.*)

" " . . . Are *Echinostomum malayanum* and *Artyfechinnostomum sufrartyfex* identical? (*Ibid., 440.*)

" " . . . *Gireterakis girardi* (n. g., n. sp.) and other suckered Nematodes. (*Ibid., 754.*)

" " . . . *Ascaris lumbricoides* and Coprophagia. (*Ind. Med. Gazet., lii, 269.*)

ROSS, R. . . . The Life-history of *Ascaris lumbricoides*. (*Brit. Med. Journ., ddccdxcvii, 60.*)

STEWART, F. H. . . Studies in Indian Helminthology. No. III. On an unsuccessful attempt to infect *Mus decumanus* with *Hymenolepis nana* Siebold, and on the Sectional Anatomy of the Parasite. (*Rec. Ind. Mus., xii, 295.*)

" " . . . Note on Ascaris infection in Man, the Pig, Rat and Mouse. (*Ind. Med. Gazet., lii, 272.*)

ANNELIDA.

STEPHENSON, J. . . On a collection of Oligochæta belonging to the Indian Museum. (*Rec. Ind. Mus., xii, 299.*)

" " . . . Zoological Results of a tour in the Far East. Aquatic Oligochæta from Japan and China. (*Mem. Asiat. Soc. Bengal, vi, 83.*)

" " . . . Oligochæta (Supplementary Report.) Fauna of the Chilka Lake. (*Mem. Ind. Mus., v, 483.*)

CRUSTACEA.

ANNANDALE, N. . .	Three plates to illustrate the Scalpellidæ and Ibidæ of Indian Seas, with synonymy and notes. (*Mem. Ind. Mus., vi, 127.*)
CHILTON, C. . .	Fauna of the Chilka Lake. Some Terrestrial Isopoda from the shore of the Lake. (*Mem. Ind. Mus., v, 459.*)
COLLINGE, W. E. .	Description of a new species of Isopoda of the genus *Synidotea*, Harger, from the Gulf of Mannar. (*Rec. Ind. Mus., xiii, I.*)
GURNEY, R. . .	On some Fresh-water Entomostraca from Ceylon (*Proc. Zool. Soc. London, 1916, 333.*)
,, ,, . .	On some Fresh-Water Entronostraca from Ceylon (*Proc. Zool. Soc., 1916, i, 333.*)
KEMP, S. . . .	Notes on Crustacea Decapoda in the Indian Museum. VI. Indian Gangonidae. VII. Further Notes on Hippotytidae. VIII. The genus *Acetes*, Milne-Edwards. (*Rec. Ind. Mus., xii, 355 and xiii, 43.*)
KEMP, S. W. . .	Notes on Crustacea Decapoda in the Indian Museum. IX. *Leander styliferus*, Milnr. Edwards, and related forms. (*Rec. Ind. Mus. xiii, 203.*)

MYRIOPODA.

SILVESTRI, F. . .	Contributions to a knowledge of the Orienta, Diplopoda Oniscomorpha, pt. 1. (*Rec. Ind. Mus., xiii, 103.*)

ARACHNOIDEA.

DALMAS, CTE. DE. .	Revision du genre *Orchestina* E. S. (*Ann. Soc. Entom. France, lxxxv, 203.*)
FENTON, L. L. . .	The great Indian spiders, (genus *Pœcilotheria*). (*Ibid., xxv, 153.*)
PHILIPE, G. P. DE RHE.	The construction of a Spider's Web. (*Journ. Bombay Nat. Hist. Soc., xxiv, 843.*)

INSECTA.

AIYAR, T. V. R. . .	A catalogue of New Wasps and Bees (Fossores Diplotera and Anthophila) described from the Indian region since 1897. (*Journ. Bombay Nat. Hist. Soc., xxiv, 711 and xxv, 92.*)

ANDREWS, E. A. .	Termites in the Luskerpore Valley. (*Qtrly. Journ. Sc. Dept. Ind. Tea. Assoc., ii (1916), 54.*)
„ „ .	Tour of the Entomologist. (*Ibid., 81.*)
„ „ .	Insect Pests of Teas, Dadap and Albizzia. (*Ibid., 87.*)
ARROW, G. J. .	The Khapra Beetle (*Trogoderma khapra*, sp. n. (*Ann. Mag. Nat. Hist., (8th ser.) xix, 481.*)
„ .	Lamellicornia Pt. II. (Rutelhinae, Desmonycinae and Euchirinae). (*The Fauna of British India.*)
BEESON, C. F. C. .	The life-history of *Diapus furtivus*, Sampson. (Platypodidae). (*Ind. Forest Rec., vi, p. 1.*)
„ „ .	Ambrosia Beetles or Pin-Hole and Spot-Hole Borers. (Col., Fam. Ipidae, Platypodidae). (*Ind. Forest., xlii, 216.*)
BELL, T. R. .	The common Butterflies of the Plains of India including those met with in the Hill Stations of the Bombay Presidency. (*Journ. Bombay Nat. Hist. Soc., xxiv, 656.*)
BENARD, G. .	Description d'une nouvelle copece du genne *Trichiorhyssemus*. (*Bull. Soc. Entom. France, 1917, 167.*)
BEZZI, M. .	On the Fruit-flies of the genus *Dacus* (*s. l.*) occurring in India, Burma and Ceylon. (*Bull. Entom. Research, vii, 99.*)
BRUNETTI, E. .	Diptera of the Simla District. (*Rec. Ind. Mus. xiii, 59.*)
CARPENTER, G. H. .	Zoological Results of the Abor Expedition. Collembola. (*Rec. Ind. Mus., viii, 561.*)
CHAMPION, G. C. .	On new and little known *Lagriidae* and *Pedilidae*. (*Trans. Entom. Soc. London, 1916, 181.*)
„ „ .	On new or little-known Xylophilidæ. (*Trans. Entom. Soc. London, 1916, 1.*)
„ „ .	New Xylophids from Australia, India and Borneo. (*Entom. Mon. Mag., liii, 1.*)
COCKERELL, T. D. A. .	Descriptions and records of Bees. (*Ann. Mag. Nat. Hist., (8th series), xix, 473.*)
„ „ .	Descriptions and records of Bees. (*Ann. Mag. Nat. Hist., (8th Ver.) xix, 282.*)
CUMMING, W. W. .	*Vanessa xanthomelæna* found occurring below 2,000 feet altitude. (*Journ. Bombay Nat. Hist. Soc., xxiv, 839.*)

D'ABREU, E. A. . . The Beetles of the Himalayas. (*Calcutta.*)

" " . . Some Cerambycids from Kurseong. (*Journ. Bombay Nat. Hist. Soc., xxv, 155.*)

DESBORDES, H. . . Description d'un *Hister* nouveau de l'Inde. (*Ann. Soc. Entom. France, xxxv, 159.*)

DISTANT, W. L. . . Rhynchota, vol. VI. Homoptera Appendix. (*Fauna of British India.*)

EDWARDS, F. W. . Notes on Culicidæ, with descriptions of new species. (*Bull. Entom. Research, London, v, 201.*)

EECKE, R. V. . . Systematische catalogus der Indo-Australische Danaiden. (*Zool. Meded. 'sRijk. Mus. Nat. Hist. Leiden, ii, 185.*)

ELLIS, E. V. . . Butterflies of Tharrawaddy and the Pegu Yoma. (*Journ. Bombay Nat. Hist. Soc., xxv, 104.*)

FELT, E. P. . . New Indian Gall Midges. (*Canad. Entom., xlviii, 400.*)

FLEUTIAUX, E. . . Descriptions de deux espèces nouvelles d'Elateridæ appartenant au genre *Dima* (Col.) (*Bull. Soc. Entom. France, 1916, No. 16, 256.*)

GIRAULT, A. A. . . A new Embidobia from India. (*The Entomologist, l, 152.*)

GOOT, P. . . . Notes on some Indian Aphides. (*Rec. Ind. Mus., xiii, 175.*)

GRAVELI, F. H. . . Some Lignicolons Beetle-Larvæ from India and Borneo. (*Rec. Ind. Mus., xii, 137.*)

GRIFFINE, A. . . Note sopra altri Grillacridi dell' Indian Museum di Calcutta. (*Bull. Soc. Entom. Italiana, xlvi, 3.*)

HAMPSON, G. F. . . Descriptions of New Pyralidæ of the subfamilies Epipaschianæ, Chrysauginæ, Endotrichinæ and Pyralinæ. (*Ann. Mag. Nat. Hist., (8th series), xix, 65.*)

JORDON, K. . . On the oriental Anthribid Genus *Apolecta*. (*Novit. Zool., xxiii, 342.*)

KUNHI KANNAR, K. . An instance of Mutation : *Coccus viridis* (Green) a Mutant from *Pulvinaria psidii* (Maskell). (*Journ. Asiat. Soc. Bengal, (N. S.) xiii, 186.*)

LAMB, C. G. . : Notes on Exotic Chloropidæ. (*Ann. Mag. Nat. Hist., (8th series), xix, 33.*)

" " . . Notes on exotic Helomyzidae, Sciomyzidae, and Psilidae. (*Ann, Mag. Nat. Hist., (8th Ser.) xix, 266.*)

LAIDLAW, F. F. .	Notes on Indian Odonata. (*Rec. Ind. Mus., xii, 129.*)
,, ,, . .	A list of the Dragonflies recorded from the Indian Empire with special reference to the collection of the Indian Museum. (*Rec. Ind. Mus., xiii, 23.*)
LIMA, A. DA C. .	Contribucao para o estudo da biologia dos calicidas Observacoes sobre a respiracao nas larvas. (*Mem. Inst. Os. Cruz., Rio de Janeiro, viii, 44.*)
MABILLE, P. & BOULLET, E.	Descriptions d'Hesperides nouveaux (Lep. Hesperiinæ, Sect. B). (*Bull. Soc. Entom. France, 1916. No. 15, 43.*)
MACFIE, J. W. S. .	Morphological changes observed during the development of the larva of *Stegomyia fasciata*. (*Bulet. Entom. Research, vii, 297.*)
MARSHALL, G. A. K. .	Coleoptera. Rhynchophora-Curculionidæ. (*The Fauna of British India.*)
,, ,, .	On new species of Indian Curculionidæ. (*Ann. Mag. Nat. Hist. (8th series), xix, 188.*)
,, ,, .	On new Weevils of the genus *Mecysmoderes* from India. (*Ann. Mag. Nat. Hist. (8th series), xix, 395.*)
MEADE-WALDO, G. .	Notes on the Apidæ (Hymenoptera) in the collection of the British Museum, with descriptions of new species. (*Ann. Mag. Nat. Hist., (8th series), xvii, 448.*)
ORMISTON, W. . .	*Nacaduba dana*, de Niceville. (*Spol. Zelan., x, 282.*)
,, ,, . .	*Terias rotiondalis.* (*Ibid., 283.*)
PAIVA, C. A. . .	Zoological Results of a tour in the Far East. Aquatic Hemiptera from the Tale Sap in Peninsular Siam. (*Mem. Asiat. Soc. Bengal, vi, 75.*)
PROUT, L. B. . .	New Geometridæ in the Joicey collection. (*Ann. Mag. Nat. Hist., (8th ser.), xx, 108.*)
,, ,, . .	New Indo-Australian Geometridæ. (*Novit. Zool., xxiii, 191.*)
RAMCHANDRA RAO, Y.	Note on some South Indian Cecidomyiids causing galls in grasses. (*Journ. Asiat. Soc. Bengal, N. S., xiii, clxxxiv.*)
RICARDO, G. . .	New species of Hæmatopota from India. (*Ann. Mag. Nat. Hist., (8th series), xix, 225.*)
ROTHSCHILD, LORD .	Some new Lepidoptera from Siam and Africa. (*Ann. Mag. Nat. Hist., xvii, 474.*)

K 2

ROTHSCHILD, LORD . Notes on Amathusiidae, Brassolidae, Morphidae, etc., with descriptions of new forms. (*Novit. Zool., xxiii, 299.*)

SCOTT, F. B. . . Notes on the larva of *Dilephila livornica* (Striped Hawk Moth). (*Journ. Bombay Nat. Hist. Soc., xxv, 156.*)

SCOTT. H. . . . Corylophidae (Coleoptera) from the Seychelles and Rangoon. (*Ann. Mag. Nat. Hist., (8th series), xix, 1.*)

SEN, S. K. . . . A preliminary note on the role of blood in Ovulation in Culicidæ. (*Ind. Journ. Med. Research, iv, 729.*)

SILVESTRI, F. . . Descrizione di alcuni Imenotheri Braconidi parassili di Ditteri Tripaneidi nell' India. (*Boll. Lab. Zool. Gen. Agrar. R. Scuola Sup. Agric., Portici, xi, 160.*)

SWINHOE, C. . . New species of Indo-Malayan Lepidoptera (*Ann. Mag. Nat. Hist. (8th series), xix, 331.*)

" " . . New species of Indo-Malayan Lepidoptera. (*Ibid., 409.*)

THEOBALD, F. V. . The Aphid of tea, coffee and caçao (*Toxoptera coffeæ*, Neitner). (*Bull. Entom. Research, vii, 337.*)

TOWNSEND, C. H. T. . Indian Flies of the sub-family Rhiniinæ. (*Rec. Ind. Mus., xiii, 851*).

TURNER, R. E. . . Notes on Fossorial Hymenoptera, xxvi. On the Genus *Homonotus*, Dahlb. (*Ann. Mag. Nat. Hist., (8th series), xix, 147.*)

" " . . Notes on Fossorial Hymenoptera, xxvii. On new species in the British Museum. (*Ibid., 317.*)

VILLAR, A. R. . . Bee-Hole Borers and a Tucktoo. (*Ind. Forest., xlii, 512.*)

WARREN, W. . . New Oriental Noctuidae in the Tring Museum. (*Novit. Zool., xxiii, 210.*)

MOLLUSCA.

ANNANDALE, N. . . The Mollusca of Lake Biwa, Japan. (*Mem. Asiat. Soc. Bengal, vi, 39.*)

AUSTEN, H. GODWIN . Zoological Results of the Abor Expedition. Mollusca. (*Rec. Ind. Mus., viii, 569.*)

HORNELL, J. . . The Indian Varieties and Races of the genus *Turbinella*. (*Mem. Ind. Mus., vi, 109.*)

HORNELL, J. . . . The Edible Molluscs of the Madras Presidency (*Madras Fisheries Bulletin, No. 11.*)

" " . . . A Revision of the Indian species of *Meretrix*. (*Rec. Ind. Mus., xiii, 153.*)

" " . . . The Indian Conch (*Turbinella pyrum*, Linn.) and its relation to Hindu Life and religion. (*Rep. Gov. Baroda Marn. Zool. Okham. Kattiawar, ii, 1.*)

" " . . . A revision of the Indian species of *Meritrix*. (*Journ. Asiat. Soc. Bengal, (N. S.) xiii, clxxxii.*)

MASSY, A. L. . . The Cephalopoda of the Indian Museum. (*Rec. Ind. Mus., xii, 185.*)

PEARSON, J. . . . Pearl Fishery Investigation, Gulf of Mannar. *Adm. Rep.* (*Mar. Biol. Ceylon, 1915, E3.*)

SOWERBY, G. B. . . Notes on the family Ampulariidæ. (*Proc. Malacol. Soc. London, xii, 65.*)

" " . . Descriptions of seven new species of Mollusca (*Ibid., 74.*)

VREDENBURG, E.. . A note on the Geological History of the genus *Turbinella*. (*Mem. Ind. Mus., vi, 123.*)

POLYZOA.

ANNANDALE, N. . . Zoological Results of a Tour in the Far East. Polyzoa Entoprocta and Ctenostomata. (*Mem. Asiat. Soc. Bengal, vi, 13.*)

THORNELY, L. R. . Report on the Polyzoa collected at Okhamandal in Kattiawar in 1905-06. (*Rep. Gov. Baroda Mar. Zool. Okhaman. Kattiawar, iii, 157.*)

FISH.

CHAUDHURI, B. L. . Fauna of the Chilka Lake. Fish, Part II. (*Mem. Ind. Mus., v, 441.*)

" " . . . Freshwater Fishes of Bengal. (*Ann. Rep. Ind. Assoc. Cult. Sc., 1916.*)

" " . Fauna of the Chilka Lake. Fish, Part III. (*Mem. Ind. Mus., v, 491.*)

DAS, B. B. . . On the Process of Development of *Rohita, Catla*, and *cirrhina mrigala* in confined Waters in Bengal. (*Proc. Ind. Assoc. Cult. Sc., iii, 6.*)

NEVILL, G. A. . . The Breeding Habits of the Mahseer (*Barbus tor*). (*Journ. Bombay Nat. Hist. Soc., xxiv, 838.*)

SUNDARA RAJ, B. . Notes on the Freshwater Fish of Madras. (*Rec, Ind. Mus., xii, 249.*)

" " . On the habits of the Hilsa (*Clupea elesha*) and their artificial propagation in the Coleroon. (*Journ. Asiat. Soc. Bengal, N. S., xiii, clxxxiv.*)

REGAN, T. . . . A revision of the Clupiod Fishes of the genera *Promolobus*, *Brevoortia* and *Dorosoma*, and their allies. (*Ann. Mag. Nat. Hist.*, (*8th series*), *xix, 297.*)

" " . . . A revision of the Clupiod Fishes of the genera *Sardinella*, *Harengula*, etc. (*Ibid., 377.*)

BATRACHIA.

ANNANDALE, N. . . Zoological results of a tour in the Far East. Batrachia. (*Mem. Asiat. Soc. Bengal, vi, 119.*)

ANNANDALE, N. & NARAYAN RAO, C. R. Indian Tadpoles. (*Journ. Asiat. Soc. Bengal,* (*N. S.*) *xiii, clxxxv.*)

NARAYAN RAO, C. R. . The occurrence of Iridocytes in the Batrachian larva, *Microhyla ornata* (*Boul.*) (*Ibid., clxxxiii.*)

REPTILIA.

ANNANDALE, N. . . A new genus of Limbless Skinks from an Island in the Chilka Lake. (*Rec. Ind. Mus., xiii, 17.*)

D'ABREU, E. A. . . The snakes of Nagpur. (*Rec. Nagpur Mus., i, 1.*)

FENTON, L. L. . . Notes on the Hamadrayad or King Cobra (*Naia bungarus*) in North Kanara. (*Journ. Bombay Nat. Hist. Soc., xxv, 151.*)

PARSHAD, B. . . Some observations on a common House-Lizard (*Hemidactylus flaviviridis,* Ruppell) of India. (*Journ. Bombay Nat. Hist. Soc. xxiv, 834.*)

RAO, C. R. N. . . Notes on *Lach sis anamallensis* and allied forms. (*Rec. Ind. Mus. xiii, 11.*)

BIRDS.

BAKER, E. C. S. . . The Game Birds of India, Burma and Ceylon. Parts xx and xxi. Phasianidæ. Genus *Crossoptilon*. (*Journ. Bombay Nat. Hist. Soc., xxiv, 623, & xxv, 1.*)

" " . . Notes on the Nidification of some Indian Falconidæ. (*Ibid,* (*10th series*), *v, 224.*).

BETHAM, R. M. . . Birds' Nesting round Ferozepore. (*Journ. Bombay Nat. Hist. Soc., xxiv, 829.*)

BHATTACHARYA, D. R.	Notes on the anatomy of a double monstrosity in the chick. (*Journ. Asiat. Soc. Bengal, (N. S., xiii, clxxxvi.*)
BUDDEN, J. A. . .	The nesting of the Rain Quail (*Coturnix coromandelica*) in the Central Provinces. (*Journ. Bombay Nat. Hist. Soc., xxiv, 822.*)
FORTY, C. H. . .	Occurrence of the Pied Imperial Pigeon (*Myristicivora bicolor*) in the Gulf of Siam. (*Journ. Nat. Hist. Soc. Siam, ii, 254.*)
HOPWOOD, J. C. & MACKENZIE, J. M. D.	A list of Birds from the North Chin Hills. (*Journ. Bombay Nat. Hist. Soc., xxv, 72.*)
INGLIS, C. M. . .	Occurrence of the Bay-backed Shrike (*Lanius vittalus*, Val.) and the late stay of the Sheldrake (*Tadorna cornuta*, Gmel.) in the Darbhanga district, Behar. (*Journ. Bombay Nat. Hist. Soc., xxiv, 824.*)
" " . .	The late stay of the Sheldrake (*Tadorna cornuta*) in the Darbhanga District, Behar. (*Ibid., 825.*)
KLOS, C. B. . .	On two new races of *Palæornis eupatria* (Linn). *Journ. Nat. Hist. Soc. Siam, ii, 218.*)
MACKENZIE, J. M. D. .	Nidification of the Golden Weaver-Bird (*Ploceella javanensis*). (*Journ. Bombay Nat. Hist. Soc., xxiv, 821.*)
O'DONEL, H. V. . .	The Eastern Baya (*Ploceus megarynchus*) nesting in the same tree as the jungle Bee (*Apis indicus*). (*Journ. Bombay Nat. Hist. Soc., xxiv, 821.*)
OSMASTON, B. B. .	The pied crested Cuckoo (*Coccystes jacobinus*) (*Journ. Bombay Nat. Hist. Soc., xxiv, 821.*)
" " .	Breeding of the Banded Crake (*Rallina superciliaris*) (*Ibid., 824.*)
WAIT, W. E. . .	Notes on Ceylon Rails, Waders, Gulls, and Terns. (*Spol. Zeylan., x, 179.*)
WHISTLER, H. . .	A note on some birds of the Gujranwala District, Punjab. (*Journ. Bombay Nat. Hist. Soc., xxiv, 689.*)
WILLIAMS, W. J. F. .	The Birds of Bangkok, (*Journ. Nat. Hist. Soc. Siam, ii, 185.*)

MAMMALIA.

ALLEN, C. W. . .	Jackals in Lower Burma. (*Journ. Bombay Nat. Hist. Soc., xxv, 146.*)

D'ABREU, E. A. . . An Albino Tiger from the Central Provinces. (*Journ. Bombay Nat. Hist. Soc., xxiv, 820.*)

GARDNER, K. G. . Remarks on *Bossondaicus* (the Tsine or Bauting) and on *Bossondaicus porteri.* (*Journ. Nat. Hist. Soc. Siam, ii, 250.*)

KLOSS, C. B. . . Notes on the Type Specimens of some Burmese and Himalayan Rats. (*Rec., Ind. Mus., xiii, 5.*)

" " . . On a new Mongoose from Siam. (*Journ. Nat. Hist. Soc. Siam, ii, 215.*)

MACKENZIE, J. M. D. . Flying Squirrel's nests. (*Journ. Bombay Nat. Hist. Soc., xxiv, 820.*)

" " . Note on *Epimys bowersi*, And., etc. (*Ibid., 820.*)

MILROY, A. J. W. . The North Kamrup Game Sanctuary, Assam. (*Ind. Forest., xlii, 452.*)

O'DONEL, H. V. . . Notes on the Burmese Forest-Badger (*Helictis personata*). (*Journ. Bombay Nat. Hist. Soc., xxiv, 819.*)

POCOCK, R. J. . . On the External characters of the Mongooses (*Mungotidæ*). (*Proc. Zool. Soc. London, 1916, 349.*)

" " . . A new genus of Ursidæ. (*Ann. Mag. Nat. Hist., (8th series), xx, 128.*)

" " . . On the external characters of the Felidæ. (*Ann. Mag. Nat. Hist., (8th series), xix, 113.*)

" " . . The structure of the Auditory Bulla in existing species of *Felidæ.* (*Ann. Mag. Nat. Hist., (8th Ser.) xix, 326.*)

" " . . On some of the Cranial and External Characters of the Hunting Leopard or Cheetah (*Acinonyx jubatus*). (*Ibid, 419.*)

ROBINSON, H. C. . On two new sub-species of squirrel from Southern India. (*Rec. Ind. Mus., xiii, 41.*)

THOMAS, O. . . On Bats of the Genera *Nyctalus*, *Tylongcleris* and *Pipistrellus*. (*Ann. Mag. Nat. Hist., (8th series), xv, 225.*)

" " . . A new Bat of the genus *Murina* from Darjeeling. (*Journ. Bombay Nat. Hist. Soc., xxiv, 639.*)

" " . . The Bandicoot of Mount Popa, and its allies. (*Ibid. 640.*)

" " . . On the Rat known as *Epimys jerdoni* from Upper Burma. (*Ibid., 643.*)

THOMAS, O. . . . The Penis-bone or "Baculum" as a guide to the classification of certain squirrels. (*Ann. Mag. Nat. Hist., (8th series), xv, 383.*)

" " . . . A new Rat from Tenasserim. (*Ann. Mag. Nat. Hist., (8th series), xvii, 425.*)

" " . . . Notes on the genus *Cremnomys*. (*Journ. Bombay Nat. Hist. Soc., xxiv, 239.*)

" " . . . On the small Hamsters that have been referred to *Cricetulus phæus* and *campbelli* (*Ann. Mag. Nat. Hist., (8th series), xix, 452.*)

THOMAS, O. & WROUGHTON, R. C. . On the squirrels obtained by Messrs. Shortridge and Macmillan on the Chindwin River, Upper Burma. (*Journ. Bombay Nat. Hist. Soc., xxiv, 224.*)

WROUGHTON, R. C. . The squirrels of the *Funambulus palmarus* group in the Peninsula. (*Journ. Bombay Nat. Hist. Soc., xxiv, 644.*)

" " . The Indian Jackals. (*Ibid., 649.*)

" " . The Langurs of Assa. (*Ibid., 653.*)

" " . The Indian Gerbils or Antelope Rats. (*Ibid., xxv, 40.*)

" " . The Slender Loris of Malabar. (*Ibid., 45.*)

" " . A New "Leaf Monkey" from the Shan States. (*Ibid., 46.*)

" " . Bombay Natural History Society Mammals Survey of India, Burma and Ceylon. Report No. 27, Bhutan Duars. (*Ibid., 63.*)

Agricultural Entomology.

ALEXANDER, C. P. . A new Ctenacroscelis (Tipulidæ). (*Insec. Inscit. Menstr. v*, 21-23.) [*Ct. rex*, n. sp., from Taungoo, Burma.]

ANDREWS, E. A. . Termites in the Luskerpore Valley (*Ind. Tea Assoc. Qrly. Journ. 1916, 54-72, 2 tabs., 5 figs.*).

ARROW, G. J. . . Coleoptera Lamellicornia, Part II, Rutelinæ, Desmonycinæ and Euchirinæ. (*Fauna of British India Series ; pp. xiii, 387, 5 tabs., 77 text figs.*).

" " . . . The Khapra Beetle (*Trogoderma khapra*, sp. n.), an Indian Grain-pest (*Ann. Mag. Nat. Hist.* (8) *xix, 481-482.*)

AWATI, P. R. . . Studies in Flies. 2 Structures other than genitalia (*Ind. Jl. Med. Res. iv, 123-139, 10 figs.*).

BALLARD, E. . . Notes on the life-history of *Megacœlum stramineum*, Wlk. (*Madras Agricl. Dept. Yearbook, 1917, pp. 83-87, figs. xviii-xx.*)

BARNES, J. H. and GROVE, A. J. The Insects attacking Stored Wheat in the Punjab and the methods of combating them (including a Chapter on the Chemistry of Respiration). (*Agric. Dept. India, Chemical Memoirs, Vol. iv, No. 6.*)

BEESON, C. F. C. . The life-history of *Diapus furtivus*, Sampson (*Ind. Forest Rec. vi, 1-29, 2 tabs.*).

BELL, T. R. . . The Common Butterflies of the Plains of India, Part xviii (*Bombay Nat. Hist. Soc., Journ., xxiv, 656-672*).

BENARD, G . . Description d'une nouvelle espece du genre *Trichiorhyssemus* (*Bull. Soc. Ent., France, 1917, pp. 167-168, fig.*). [*T. babaulti*, n. sp., from Surada, Ganjam District.]

BEZZI, M. . . On the Fruitflies of the genus *Dacus* (s. l.) occurring in India, Burma and Ceylon (*Bull. Ent. Res. vii, 99-121*).

BRUNETTI, E. . . Diptera of the Simla District (*Rec. Ind. Mus. xiii, 59-101*).

BURKILL, I. H. . . Notes on the Pollination of Flowers in India. Note No. 8, Miscellaneous. (*Journ.* and *Proc. As. Soc. Bengal (n. s.) xii, 239-265, fig.*). [Insects concerned in pollination.]

CAMPION, H. . . On Fabricius' Types of Odonata in the British Museum (Natural History). (*Ann. Mag. Nat. Hist. (8) xix, 441-450.*)

CHAMPION, G. C. . New Xylophilids from Australia, India and Borneo. (*Ent. Mo. Mag. 1917, 1-4.*)

" " . . On new and little-known *Lagriidæ* and *Pedilidæ*, (*Trans. Ent. Soc. 1916, 181-242, 2 tabs.*) [Eleven new species of Pedilidæ and four others from Indian Region.]

" " . . On new or little-known *Xylophilidæ*. (*Trans. Ent. Soc. 1916, 1-64, tab. I, ii.*) [Thirty-one new Indian spp.]

" " . . On new exotic Scraptiina (*Ent. Mo. Mag. 1916 pp. 233-253, 265-274, tab.*). [13 new Indian spp.]

" " . . Some Coleoptera from Northern India (*Ent. Mo. Mag. 1917, 52-55*). [*Mycetophagus sulcicollis*, n. sp., *M. alni, Penthe almorensis*, n. spp. from W. Almora.]

CHAMPION, H. G. .	First impressions of a North Indian Station in the Rains (*Ent. Mo. Mag. 1917, 81-84*). [Insects found around Dehra Dun.]
CHRISTOPHERS, S. R. .	A new Anopheline with unspotted wings from Mesopotamia (*Anopheles lukisii*). (*Ind. Jl. Med. Res. iv, 120-122.*)
COCKERELL, T. D. A.	Arthropods in Burmese Amber (*Psyche, xxiv, 40-45, figs.*) [Six n. spp.]
,, ,, .	Descriptions and Records of Bees, *lxxiv.* (*Ann. Mag. Nat. Hist.* (*8*) *xix, 282-290.*) [Various new species and records of localities from N. W. India.]
,, ,, .	Fossil Insects (*Ann. Ent. Soc. America, x, 1-22, figs.* [Two n. g. and spp. Hymenoptera ; 1 n. g. 4 n. spp. Diptera ; one n. sp. Coleoptera ; all from Burmese Amber of Miocene or older date.]
CORNWALL, J. W. AND MENON, T. KESAVA.	A Contribution to the study of Kala-Azar (III). (*Ind. Journ. Med. Res. iv, 672-687.*) [Experiments with flagellates of *Leishmania donovani* ingested by *Clinocoris hemipterus* (*Cimex rotundatus*).]
CRAWFORD, J. C. .	Nine new species of Hymenoptera. (*Insec. Inscit Menstruus iv, 101-107.*) [*Tetrastichus pyrillæ Ooencyrtus pyrillæ* from India.]
CUMMING, W. W. .	*Vanessa xanthomelæna* found occurring below 2,000 feet altitude. (*Bombay Nat. Hist. Soc. Journ. xxiv, 839.*)
D'ABREU, E. A. .	Some Cerambycids from Kurseong. (*Bombay Nat. Hist. Soc. Journ. xxv, 155.*)
DERHE-PHILIPE, C. W. V.	The Butterflies of Lahore. (*Bombay Nat. Hist. Soc. Journ. xxv, 136-142.*)
DESBORDES, H. . .	Contribution à la Connaissance des Histerides. 2ᵉ memoire ; Synopsis de divers groupes d' Histeridæ ; I. Genre Hololepta, Payk.; Notes Synonymiques et tableau des especes de l'Inde et de l'archipel Malais. (*Ann. Soc. Ent. France, 1916, 297-326.*)
DISTANT, W. L. .	Rhynchotal Notes, LXI. *Ann. Mag. Nat. Hist.* (*8*) *288-294* (*Sept. 1916.*)
DUTT, H. L. . .	*Agrotis* at Colgong and Ghogha in 1915-16. (*Bihar Agricl. Journ. iv, 15-23.*)

EDWARDS, F. W. . Notes on Culicidæ, with descriptions of new species (*Bull. Entom. Research vii, 201-229, figs.*). [Synonymy of various Indian species; *Aedes ceylonicus*, sp. n., from Colombo; *A. yerburyi*, sp. n., from Kitli, Ceylon.]

" " . . Three new species of the dipterous genus *Olbiogaster*, O. S., in the British Museum Collection. (*Ann. Mag. Nat. Hist.* (8) *xvi, 502-505.*) [*O. orientalis*, n. sp. (Pundaluoya).]

ELLIS, E. V. . . Butterflies of Tharrawaddy and the Pegu Yoma. (*Bombay Nat. Hist. Soc. Journ. xxv, 104-120, map.*)

FELT, E. P. . . New Indian Gall Midges (Diptera). (*Entom. News xxviii, 73-76.*)

FENTON, L. L. . . The "Preying Mantis" as an Entomologist. (*Bombay Nat. Hist. Soc. Journ. xxv, 154-155.*)

FLETCHER, T. BAINBRIGGE. Tiger Beetle Borer of Coffee. (*Planters Chronicle, xii, 14-16.*)

" " . . Agricultural Entomology in India, 1915-16 (*Board of Scientific Advice Annual Report*).

FLEUTIAUX, E. . . Descriptions de deux especes nouvelles d' Elateridæ appartenant au genre *Dima*. (*Bull. Soc. Ent. France, 1916, 256-257.*)

FRASER, F. C. . . Note on a Flight of Sphingidæ. (*Bombay Nat. Hist. Soc. Journ. xxv, 155-156.*)

GILL, CLIFFORD A. . Malaria in Muscat. (*Ind. Jl. Med. Res. iv, 190-235, t. xiii-xvi, 2 maps, 1 chart.*)

GRANDI, G. . . Contributo alla conoscenza degli Agaonini (Hymenoptera, Chalcididæ) di Ceylon e dell' India (*Boll. Lab. Zool. Agrar. R. Scuola Sup. Portici xi, 181-234, figs.*).

GRAVELY, F. H. . Some lignicolous Beetle-larvæ from India and Borneo. (*Rec. Ind. Mus. xii, 137-175, tabs. xx-xxiii.*)

GUPTA, S. R. . . Insects injurious to crops. (*Bulletin No. 1 of 1916, Assam Agricl. Dept.*).

" " . . Rice Hispa; Rice Bug; Rice Grasshopper; Rice Stem Borer; Brinjal Borers; Surface Caterpillars; Plant Lice or Aphis; The White Ants; Insect Pests of Stored Grains, seeds, etc. (*Assam Agricl. Dept.*, Leaflets 1-9 of 1916).

HAMPSON, SIR G. F. .	A Classification of the Pyralidæ, Sub-family Gallerianæ. (*Novit. Zoolog. xxiv, 17-58.*)
,, ,, .	Descriptions of new Pyralidæ. (*Ann. Nat. Hist.* (8) *xviii, 126-160, 349-373 ; xix, 65-100.*)
,, ,, .	Descriptions of the new species of the family Arctiadæ in the British Museum. (*Novit. Zoolog. xxiii, 230-240*. [*Pericallia coorgensis* ; Coorg.]
HIRST, S. . . .	On the occurrence of the Tropical Fowl Mite (*Liponyssus bursa*, Berlese) in Australia, and a new instance of its attacking Man (*Ann. Nat. Hist.* (8) *xviii, 243-244*) [*Leiognathus morsitans*, Hirst, from India, etc., is a synonym of this.]
HUTCHINSON, C. M. .	The Pebrine Disease of Silkworms in India. (*Pusa Bull. No. 75.*)
JACKSON, A. C. AND LEFROY, H. M.	Some Fly Poisons for outdoor and hospital use. (*Bull. Ent. Res. vii, 327-335.*)
JANSON, O. E. . .	Descriptions of two new species of Cetoniidæ (*Ent. Mo. Mag. 1917, 5-6, fig.*).
JOICEY, J. J. AND TALBOT, G.	New *Delias* and other Butterflies from the East. (*Ann. Mag. Nat. Hist.* (8) *xviii, 63-67, tabs. 4, 5*).
JORDAN, K. . .	On the Oriental Anthribid genus *Apolecta*. (*Nov. Zool. xxiii, 342-349.*)
KARNY, H. W. AND J. DOCTERS VAN LEEUWEN-REIJNVAAN.	Beitrage zur Kenntniss der Gallen von Java. Zweite Mitteilung uber die javanischen Thysanopterocecidien und deren Bewohner. (*Zeits. wiss. Insektenbiologie xi, 32-39, 85-90, 138-147, 203-210, 249-256, 324-331 ; xii, 15-22, 84-94, 125-134.*)
KNAB, F. . .	The earliest name of the Yellow Fever Mosquito. *Insec. Inscit. Menstr. iv, 59-60.* [*Culex argenteus*, Poiret 1787.]
LAIDLAW, F. F. . .	Notes on Indian Odonata. (*Rec. Ind. Mus. xii, 129-136.*)
,, ,, . .	A List of the Dragonflies recorded from the Indian Empire, Part I (*l. c. xiii, 23-40, tab. ii*).
LAMB, C. G. . .	Notes on Exotic Chloropidæ. (*Ann. Mag. Nat. Hist.* (8) *xix, 33-58, figs.*). [*Pachylopus lituraticrus* var. from Manganallur, *Steleocerus ensifer*, Thoms. (?) from Mysore ; *Eurina oculata*, n. sp., from Hagari ; *Lagaroceras pulchellum*, n. sp., from Durban and Coimbatore ; *Metapostigma sauteri* from Coimbatore ; *Chalcidomyia polita*, Meij., from Taliparamba ; *Chromatopterum lacteiventre*, n. sp., from Peradeniya ; *Chlorops zeylanica*, n. sp., from Peradeniya.]

LAMB, C. G. . . . Notes on Exotic Helomyzidæ, Sciomyzidæ and Psilidæ. (*Ann. Mag. Nat. Hist. (8) xix 266-273*).

LAMEERE, A. . . . Notes sur quelques *Prioninæ* du Yunnan (*Bull. Soc. Ent. France 1916, 257-259.*)

LEEFMANS, S. . . . Bijdrage tot het *Helopeltis*-vraagstuk voor de Thee. (*Department van Landbouw, Java; Med. Proefstrat. voor Thee,* No. L, *pp. 214, 11 tabs, 2 charts*). [An account of *Helopeltis* on Tea in Java. Of considerable importance to tea-growers in India. Summary in English. Also issued as No. 26 of the *Mededeelingen van het Laboratorium voor Plantenziekten.*]

MABILLE, P. AND BOULLET, E. Descriptions d'Hesperides nouveaux (*Bull. Soc. Ent. France, 1916, 243-247.*)

MACLEOD, N. C. . White Ants crossing open ground. (*Bombay Nat. Hist. Soc. Journ. xxiv, 845-846.*)

MADAN MOHAN LAL. . Hints on Silkworm rearing in the Punjab. (*Punjab Dept. Agric. Leaflet, 20 pp.*)

,, ,, . . . Some important Insect Pests of Cotton in the Punjab. (*Dept. of Agric. Punjab.*)

MARSHALL, G. A. K. . On new species of Indian Curculionidæ,—Part III. (*Ann. Mag. Nat. Hist. (8) xix, 188-198.*)

,, ,, . Rhynchophora :—Curculionidæ, Part I. (*Fauna of British India Series, Pages xi, 367, 108 figs.*)

,, ,, . On new Weevils of the genus *Mecysmoderes* from India. (*Ann. Mag. Nat. Hist. (8) xix, 395-404.*) 7 n. spp.

MAULIK, S. . . . On Cryptostome Beetles in the Cambridge University Museum of Zoology. (*Proc. Zool. Soc. 1916, pp. 567-589.*) [*Agonia cherrapunjiensis,* n. sp. from Assam.]

MEYRICK, E. . . . Exotic Microlepideptera, *Vol. i, pt. 20, Vol. ii, pt. 1.* [Numerous new Indian species and genera.]

,, ,, . . . *Phalonia manniana* and its allies. (*Ent. Mo. Mag. 1916, 275-278.*) [*Ph. mellita,* n. sp., Bengal, Ceylon, N. Australia.]

MORLEY, C. . . . Some Stephanidæ with descriptions of new species. (Entom. *l.* 105-113.) [*Diastephanus frontilinea,* n. sp., from Rangpur.]

MOTTRAM, J. C. . . An Experimental Determination of the Factors which cause Patterns to appear Conspicuous in Nature. (*Proc. Zool. Soc. 1916, 383-418, figs.*). [Deals with Indian Diurnal Lepidoptera.]

MUIR, F. . . .	On the Synonymy of *Delphax maidis*, Ashm. (*Canad. Ent. xlix, 147.*) [*Pundaluoya simplicia*. Dist., is regarded as a synonym of *Peregrinus maidis*, Ashm.]
NEWTON, L. V. . .	The Domestication of the Indian Honey-bee (*Agricl. Journ. India, xii 44-57, tabs. 2-5, figs.*)
ORMISTON, W. . .	*Nacaduba dana*, de Nicev. (*Spolia Zeylan. x, 282.*)
PILLAI, R. M. . .	Leaflet on Beetle Pests of Coconut. (*Travancore Agricl. Dept.*, in vernacular.)
PROUT, L. B. . .	New Indo-Australian Geometridæ. (*Novit. Zoologicæ, xxiii, 191-209.*)
,, ,, . .	On new and insufficiently known Indo-Australian Geometridæ. (*Novit. Zoolog. xxiv, 293-317*). [Many new Indian species.]
QUAINTANCE, A. L. AND BAKER, A. C.	Aleurodidae or White flies attacking the orange, with descriptions of three new species of economic importance. (*Journ. Agricl. Res. vi, 459-472, 6 tabs., 3 figs.*) [Two n. spp. from India.]
RABAUD, E. . . .	Sur les Hymenopteres parasites des ootheques d'Orthopteres. (*Bull. Ent. Soc., France, 1917, 178*). [Reference to *Lepidoscelis viatrix*, Brues, attached by mandibles to the abdomen of *Colemania sphenarioides*.]
RAMACHANDRA RAO, Y.	*Adisura atkinsoni*, Moore. (*Madras Agricl. Dept. Yearbook, 1917, pp. 87-91, fig. xxi.*)
RAMAKRISHNA AYYAR, T. V.	A Catalogue of new Wasps and Bees (*Fossores, Diploptera* and *Anthophila*) described from the Indian Region since 1897. (*Bombay Nat. Hist. Soc. Journ. xxv, 92-103.*)
,, ,,	A Catalogue of New Wasps and Bees described from the Indian Region since 1897. Part II. (*Bombay Nat. Hist. Soc. Journ. xxiv, 711-721.*)
,, ,,	A new pest of the Coconut palm on the West Coast (*Contheyla rotunda*, Hmp.) (*Madras Agricl. Dept. Yearbook, 1917, pp. 91-96, figs. xxii-xxiii.*)
,, ,,	Note on the egg-laying habits of the Agathi Weevil (*Alcides bubo, Fb.*) (*l.c., pp. 97-99.*)
,, ,,	Insects in Agriculture (pamphlet ; 16 pp.).
RAMAKRISHNA. AYYAR, T. V.	Insecticide Spraying for the Mango Hopper (*Madras Agricl. Calendar 1917-18, pp. 72-74.*)
,, ,,	The Mango Hopper Pest and its control. A few home-made remedies against some common plant pests. (*Leaflets iii and v of 1917, Madras Agricl. Dept.*)

Ramakrishna Ayyar, T. V.	Notes on the Life-history and Habits of the "Eye Fly," *Siphonella funicola*, de Meji. (*Madras Agricl. Yearbook 1917, pp. 76-83, figs. xii-xvii.*)
Ratiram Khamparia	Leaflet (in Hindi) on Bag-nets. (*Central Prov. Agricl. Dept.*)
Ricardo, G. . .	New species of *Hæmatopota* from India. (*Ann. Mag. Nat. Hist. (8) xix, 225-226.*)
Rothschild, Lord .	Some apparently new *Notodontidæ*. (*Novit. Zoolog. xxiv, 231-264*). [*Stauropus sikkimensis khasianus*, subsp. nov. (Khasi Hills); *S. apiculatus*, spec. nov. (Khasi Hills); *S. notodontina*, sp. nov. (Khasi Hills); *Chadisra albobrunnea*, sp. nov. (Khasi Hills); *Tarsolepis rufobrunnea*, sp. nov. (Travancore, Khasi Hills); *Phalera elongata*, spec. nov. (Khasi Hills); *Turnaca mediofascia* sp. nov. (Khasi Hills); *Baradesa omissa* sp. nov. (Khasi Hills, Malay Penins.); *Euhampsonia niveiceps occidentalis*, subsp. nov. (N. W. Himalayas).]
Schmidt, E. . .	Zur Kenntniss der Genera *Saceseurus* Breddin und *Cylindrostethus* Fieber. (*Stett. Ent. Zeit. lxxvi, 359-364.*) [Two n. spp. from Ceylon.]
Scott, F. B. . .	Notes on the larva of *Deilephila livornica* (Striped Hawk Moth). (*Bombay Nat. Hist. Soc. Journ. xxv, 156.*)
" " . .	Notes on the larva of *Daphnis nerii* in India. (*Entom. l., 113-114*).
Scott, H. . . .	*Corylophidæ* from the Seychelles and Rangoon. (*Ann. Mag. Nat. Hist. (8) xix, 1-33, tabs.*)
Sen, P. C. . .	The Mango Shoot-borer (*Alcides frenatus*). (*Bengal Agricl. Dept. Leaflet No. 2 of 1916.*)
Sen, S. K. . .	A Preliminary Note on the Role of Blood in Ovulation in Culicidæ. (*Ind. Journ. Med. Res. iv, 729-753, figs.*).
Shoebotham, J. W. .	Notes on Collembola, Part 4. The Classification of the Collembola. (*Ann. Mag. Nat. Hist. (8) xix, 425-436.*)
Silvestri, F. . .	Descrizione di alcuni Imenotteri Braconidi parassiti di Ditteri Tripaneidi nell' India. (*Boll. Lab. Zool., R. Scuola d'Agric. Portici, xi, 160-169, figs.*).
" , . .	Prima notizia sulla presenza della mosca delle olive e di un parassita di essa in India. (*Reale Accad. dei Lincei (5) xxv, 424-427, figs.*).

SILVESTRI, F. . . . Sulle specie di Trypaneidæ (Diptera) del genere *Carpomyia* dannose ai frutti di *Zizyphus*. (*Boll Lab. Zool. Portici, xi, 170-182, figs.*) [Life-history of *C. vesuviana*.]

SOLOMONS, C. C. . *Cassia nodosa* tree defoliated by caterpillars of *Catopsilia pomona*, Fabr. (*Spolia Zeylan. x, 281.*)

" " . . Flight of *Brana calopasa*. (*l.c., p. 282.*)

SWINHOE, C. . . New species of Butterflies and Moths from Australia, Africa, and the Indo-Malayan Region. (*Ann. Mag. Nat. Hist.* (8) *xviii, 480-490.* [*Isamia noblei*, n. sp., Rangoon; *Agrisius plumbeonigra*, n. sp., Khasis; *Thinopteryx crocopterata assamensis*, Assam, Sikkim; *Dichocrocis pulalis*, n. sp., Maymyo.]

" " . . . New Indo-Malayan Lepidoptera. (*Ann. Mag. Nat. Hist.* (8) *xviii, 209-211.*)

" " . . . New species of Indo-Malayan Lepidoptera. (*Ann. Mag. Nat. Hist.* (8) *xix, 331-343.*) [New Indian species.]

" " . . . New species of Indo-Malayan Lepidoptera. (*Ann. Mag. Nat. Hist.* (8) *xix, 409-416.*) [*Arhopala dascia* n. sp., from Toungoo, Burma.]

THEOBALD, F. V. . The Aphid of Tea, Coffee, and Cacao. (*Toxoptera coffeæ*, Nietner). (*Bull. Ent. Res. vii, 337-342, figs.*).

TURNER, R. E. . . Notes on Fossorial Hymenoptera, XXIV. On the Genus *Nitela*, Latr. (*Ann. Mag. Nat. Hist.* (8) *xviii, 343-346.*)

" " . . . Notes on Fossorial Hymenoptera, XXVI. On the Genus *Homonotus*, Dalhb. (*Ann. Mag. Nat. Hist.* (8) *xix, 147-151.*) [*H. nursei*, n. sp., from Deesa.]

" " . . . Notes on Fossorial Hymenoptera, XXII. On new species in the British Museum. (*Ann. Mag. Nat. Hist.* (8) *xix, 317-326.*) [New Indian species.]

" " . . . Notes on the Wasps of the genus *Pison* and some allied genera. (*Proc. Zool. Soc. 1916, pp. 591-625.*) [Key to Indian *Pison* spp.; *Pison differens*, n. sp., from Shillong; *P. fasciatus*, Rad., from Chapra.]

WARREN, W. . . New Oriental Noctuidæ in the Tring Museum, (*Novit. Zoologicæ xxiii, 210-227.*)

WATERSTON, J. . . Notes on Coccid-infesting Chalcidoidea, III. (*Bull. Ent. Res. vii, 311-325, figs.*) . [*Aspidiotiphagus citrinus* from *Chionaspis graminis* at Peradeniya.]

WHEELER, W. M. . An Indian Ant introduced into the United States. (*Journ. Ec. Ent. ix, 566-569, figs.*). [*Triglyphothrix striatidens*, Emery, recently found in Louisiana.]

WILEMAN, A. E. AND SOUTH, R. New species of Heterocera from Japan and Formosa in the British Museum. (*Entom. I, 25-29.*) [*Sypna diversa*, n. sp., from Formosa and Darjiling.]

" " New species of Noctuidæ and Geometridæ from Formosa. (*Entom. 1917, 53-57*). [*Anepa irrorata*, n. sp., from Sikkim and Formosa.]

WILLCOCKS, F. G. . The Insect and Related Pests of Egypt, Vol. I. The Insect and Related Pests injurious to the Cotton Plant. Part I, the Pink Bollworm. (*Sultanic Agricl. Society, Cairo. Qrto., pp. 339, 10 tabs., 17 figs.*) [A comprehensive account of *Gelechia gossypiella.*]

ZETEK, J. . . . The Ecology of Bubonic Plague. (*Ann. Ent. Soc. America x, 198-206*). [Summarized result of Plague Investigations in India.]

Forest Entomology.

BEESON, C. F. C. . Indian Forest Records, Vol. vi, Part i (Calcutta 1917). The Life History of *Diapus furtivus*, Sampson.

Veterinary Science.

AWATI, P. R. . . Studies in Flies. Contributions to the study of specific differences in the Genus Musca. (2) Structures other than Genitalia. (*Ind. Jour. of Med. Res. Vol. iv, 1916, p. 123.*)

BELFANTI, S. AND ASCOLI, A. Notes on Fowl plague and Foot and Mouth Disease (*Clinica Veter. Vol. xxxix, 1916, p. 577.*)

BEMIS, H. E. . . Fistula of the Withers. (*Jour. Amer. Vet. Med. Assoc. Vol. l, 1916, p. 420.*)

BERGH, H. . . . The treatment of Tetanus with Tetanus anti-Toxin. (*Jour. Amer. Vet. Med. Assoc. Vol. xlix, 1916, p. 86.*)

BESNOIT AND CUILLE . Intradermal Palpebral Tuberculin test. (*Rev. Gen. de Méd. V ét. 1916.*)

BIMBI, P. . . . Equine Piroplasmosis in Sardinia. (*Moderno Zooiatro Vol. V, 1916, p. 225.*)

BOUILLIEZ, M. . Certain diseases occurring in the middle Shari area (Central Africa). (*Bull. Soc. Path. Exot. Vol. ix, 1916, p. 143.*)

" " . . A Filaria of the toad in the Shari area (Central Africa). (*Bull. Soc. Path. Exot. Vol. ix, 1916, p. 153.*)

BOUIN . . . Trypanosomiasis of Dromedaries in Western Morocco. (*Rec. de Méd. Vét. Vol. xcii, 1916, p. 463.*)

BRIDRÉ, J. . . Epizootic Lymphangitis in France. Diagnosis and treatment. (*Rec. de Méd. Vét. Vol. xci, 1916, p. 136.*)

BROOKS, H. . . Effects of heredity in bovine tuberculosis. (*Vet. Jour. Vol. lxxii, 1916, p. 16.*)

BULL, L. B. . . A granulomatous affection of the horse. Habronemic Granulomata (Cutaneous Habronemiasis of Railliet). (*Jour. Comp. Path. and Therap. Vol. xxix, 1916, p. 187.*)

CARINI, A. . . . Nambi-uvu; a disease of dogs and its parasite. (*Cent. f. Bakt. I Abt. Orig. Vol. lxxvii, 1915, p. 265.*)

CARPANO, M. . . The study of Para-charbon microbes in special relation to B. Anthracis. (*Ann. de Igiene. Vol. xxvi, 1916, p. 50.*)

" " . . Sulla diagnosi batteriologica del carbonchio ematico con piccole quantita di materiale viru'ente. (*Bull. de L'Inst. Pasteur Vol. xiv 1916, p. 713.*)

" " . . Rabies. A rapid method of staining Negri bodies and the special structures of these bodies brought out by this method. (*Clinica Veter. Vol. xxxix, 1916, p. 347.*)

CHAMBERS, T. . . Internal Strangles. (*Vet. Record Vol. xxix, 1916-17, p. 350.*)

CHAUSSÉ . . . The virulence of the muscles and of the apparently healthy Lymphatic glands in generalised Tuberculosis of the Ox and pig. (*Ann. de L'Inst. Past. Vol. xxxi, 1917, p. 1.*)

COOLEDGE, L. H. . Is the bacillus of contagious abortion in cows pathogenic for human beings? (*Jour. Med. Res. Vol. xxxiv, 1916, p. 458.*)

" . Agglutination studies of milk from cows affected with contagious abortion. (*Proc. Soc. Amer. Bacteriol. Vol. xlii, 1915, p. 352.*)

CORNWALL, J. W. AND MENOR, T. K. — On experimental immunization against rabies by the method of Phisalix. (*Ind. Jour. Med. Res. Vol. iv, 1916, p. 688.*)

COSGO, G. AND AGUZZI, A. — The virulence of the blood of animals infected with Foot and Mouth disease. (*Clinica Veter. Vol. xxxix, 1916, p. 193.*)

COTTON, C. E. . . . Contagious abortion from a practitioner's standpoint. (*Jour. Amer. Vet. Med. Assoc. Vol. l. 1916, p. 12.*)

CRAWLEY, H. . . . The sexual evolution of sarcocystis muris. (*Proc. Acad. Nat. Science, Philadelphia, Jan. 1916, p. 2.*)

DALE, H. H. AND HARTLEY, P. — Anaphylaxis to the separated protein of Horse serum. (*Biochem. Jour. Vol. x, 1916, p. 408.*)

DALRYMPLE, W. H. . Anthrax (charbon). (*Jour. Amer. Vet. Med. Assoc. Vol. l, 1916, p. 831.*)

DELEPINE, S. . . . Contribution to the study of delayed or latent tuberculous infection. (*Extrait des Ann. de L'Inst. Past. Vol. xxx, 1916, p. 600.*)

DE MELLO, F. AND BRAZDESA, L. J. — A contribution to the study of Hæmoprotozoa in Portuguese India. (*Ind. Jour. Med. Res. Vol. iii, 1916, p. 731.*)

DE VINE, J. F. . . Some advantages of sanitary precautions in cattle practice. (*Jour. Amer. Vet. Med. Assoc. Vol. l, 1916, p. 23.*)

DOUVILLE . . . Treatment of Epizootic Lymphangitis. Experiments with Galyl. (*Rec. de Méd. Vét. Vol. xci, 1916, p. 144.*)

EICHHORN, A. AND POTTER, G. M. — The present status of the abortion question. (*Jour. Amer. Vet. Med. Assoc. Vol. l, 1917, p. 29.*)

ELLIS, H. A. . . The diagnosis of tuberculosis by tuberculin. (*Lancet Vol. cxci, p. 638, 1916.*)

FANTHAM, H. B. AND PORTER, A. — The significance of certain natural flagellates of insects in the evolution of disease in vertebrates. (*Jour. of Parasit. Vol. ii, 1916, p. 149.*)

FERRY, N. S. . . The ophthalmic test for glanders, with a simplified method of procedure. (*Jour. Amer. Vet. Med. Assoc. Vol. l, 1917, p. 41.*)

FINZI, G. . . . Leishmaniasis and Tuberculosis in the dog. (*Bull. Soc. Path. Exot. Vol. ix, 1916, p. 429.*)

FIORI, C. AND DELANOE, MME P. — The dimorphism of the Mazagan Trypanosome. (*Bull. Soc. Path. Exot. Vol. ix, 1916, p. 130.*)

FRANKLIN, O. M. AND HASLAM, T.P. — The strength and composition of blackleg vaccines. (*Jour. Inf. Dis. Vol. xix, 1916, p. 408.*)

GAIGER, S. H. . . Glanders in Man. (*Jour. Comp. Path. and Therap.*) *Vol. xxix, 1916, p. 26.*)

GALLAGHER, B. . . Fowl Cholera and other Hæmorrhagic Septicæmia immunization experiments. (*Jour. Amer. Vet. Med. Assoc. Vol. l, 1916, p. 708.*)

GHOSH, M. N. . . Cattle poisoning by Juar (Andropogan sorghum) and its prevention. (*Agr. Jour. Ind. Vol. xi, 1916, p. 377.*)

GILTNER, W., COOLEDGE, L. H. AND HUDDLESON, J. F. — A study of the milk in Bovine Infectious Abortion. (*Jour. Amer. Vet. Med. Assoc. Vol. l, 1917, p. 157.*)

GOOD, E. S. AND SMITH, W. V. — The production of a hyperimmune serum for Infectious Abortion in Mares. (*Jour. Inf. Dis. Vol. xviii, 1916, p. 397.*)

GOOD, E. S. AND CORBETT. — A study of gas production by different strains of B· Abortivo Equinus. (*Jour. Inf. Dis. Vol. xviii, 1916, p. 586.*)

HADLEY, F. B. AND LOTHE, H. — The bull as a disseminator of contagious abortion. (*Jour. Amer. Vet. Med. Assoc. Vol. l, 1916, p. 143.*)

HALL, M. C. . . Contributions to the study of parasite affections of the horse. A clinical study of Equine strongylidosis. (*Jour. Amer. Vet. Med. Assoc. xlix, 1916, p. 102.*)

HARDENBERGH, J. B. AND BOERNER, F. — Vaccination against Hæmorrhagic Septicæmia. (*Jour. Amer. Vet. Med. Assoc. Vol. xlix, 1916, p. 55 & Vol. l, 1917, p. 868.*)

HARDENBERGH, J. B. AND UNDERHILL, B. M. — The reliability of all proliferation changes in the diagnosis of Rabies. (*Jour. Amer. Vet. Med. Assoc. Vol. xlix, 1916, p. 663.*)

HARDENBERGH, J. B. . Vaccination against Infectious Arthritis of Foals due to B. Abortus Equi. (*Jour. Amer. Vet. Med. Assoc. Vol. l, 1917, p. 331.*)

HART, G. H. . . Glanders in wild animals kept in zoological gardens. (*Jour. Amer. Vet. Med. Assoc. Vol. l, 1917, p. 189.*)

HIGGINS, C. AND WICKWARE, A. B. — Avian tuberculosis. (*Vet. Jour. Vol. lxxii, 1916, p. 141.*)

HOMMER, A. . . On the concentration of Anti-toxic sera. (*Biochem. Jour. Vol. x, 1916, p. 280.*)

KOLMER, J. A., TRIST, M. E. AND HEIST, G. D. — Compliment fixation in intestinal parasitism of dogs. (*Jour. Inf. Dis. Vol. xviii, 1916, p. 88.*)

KONRADI, D. . . . Transmission of rabies by heredity. (*Ann. de L'Inst. Past. Vol. xxx, 1916, p. 33.*)

LANE, C. . . . The Genus Ankylostoma in India and Ceylon. (*Ind. Jour. Med. Res. Vol. iv, 1916, p. 74.*)

LANKESTER, A. . . The gland index in tuberculosis. (*Ind. Jour. Med. Res. Vol. iv, 1916, p. 285.*)

LEYTON, A. S. AND LEYTON, H. G. Observation on the treatment of Anaphylaxia, (*Lancet Vol. cxci, 1916, p. 1171.*)

McCARRISON, R. . The experimental production of congenital Goitre. (*Ind. Jour. Med. Res. Vol. iv, 1916, p. 183.*)

McFADYEAN, J. . Tuberculous mastitis in the cows. Its pathogenesis and morbid anatomy and histology. (*Jour. Comp. Path. and Therap. Vol. xxx, 1917, p. 57.*)

McFADYEAN, J. AND SHEATHER, A. L. The experimental transmission of Johne's disease to cattle, sheep and goats with notes regarding the occurrence of natural cases in sheep and goats. (*Jour. Comp. Path. and Therap. Vol. xxix, 1916, p. 62.*)

McFADYEAN J., SHEATHER, A. L. AND EDWARDS, J. T. Johne's Disease. The reaction of animals to Johnin, (*Jour. Comp. Path. and Therap. Vol. xxix, 1916, pp. 134 and 201.*)

McGREGOR, M. E. . Resistance of the eggs of Stegomyia fasciata (Aedes calopus) to conditions adverse to development. (*Bull. Ent. Res. Vol. vii, 1916, p. 81.*)

MACALISTER, G. H. K. . Kumri. Combined diffuse sclerosis and central poliomyelitis of horses. (*Mem. Dept. Agr. Ind. Vet. Sc. Vol. ii, No. 8, 1917.*)

MACFIE, J. W. S. . A note on a trypanosoma of the black rat. (*Ann. Jl. Trop. Med. and Parasit. Vol. ix, 1915, p. 527.*)

MARKOFF, W. U. . Piroplasmosis and other diseases of domesticated animals due to blood parasites in the Balkans. (*Arch. f. Schiff. u Trop. Hyg. Vol. xx, 1916, p. 313.*)

MARIN AND HENRY . Anthrax in the neighbourhood of Constantine. (*Bull. Soc. Path. Exot. Vol. ix, 1916, p. 79.*)

MARKUS . . . Transmission of tuberculosis from the pig to man. Retransmission to a calf. (*Rev. Gén. de Méd Vét. Vol. xxv, 1916, p. 466.*)

MASON, F. E. . . Tuberculosis in camels. (*Jour. Comp. Path. and Therap. Vol. xxx, 1917, p. 80.*)

MESNIL, F. AND BLANCHARD, M. The susceptibility of trypanosomes of human origin to normal human serum. (*Bull. Soc. Path. Exot. Vol. ix, 1916, p. 81.*)

MITZMAN, M. B. . A digest of the insect transmission of disease in the orient, with special reference to the experimental conveyance of T. Evansi. (*New Orleans Med. Jour. Vol. L. xix, 1916, p. 416.*)

MORI, N. . . . Etiology and special prophylaxis of exudative pleuro-pneumonia of goats. (*Nuovo Erocolani Vol. xxi, 1916, pp. 196, 205 and 221.*)

" " . . . Hyphomycetic nature of the corpuscles in exudation pleuro-pneumonia of goats. The specific organism to the disease is an aspergillus. (*Pathologica Vol. viii, 1916, p. 311.*)

NEWTON, R. C. . . An appeal to the Veterinarians to help in the fight against tuberculosis. (*Jour. Amer. Vet. Med. Assoc. Vol. xlix, 1916, p. 810.*)

NUTTALL, G. H. F. . Ticks on the Belgian Congo, and the diseases they convey. (*Bull. Ent. Res. Vol. vi, 1916, p. 313.*)

OLIVER, E. W. . . Cattle breeding with special reference to the milch cow. (*Agr. Jour. Ind. Vol. xi, 1916, p. 168.*)

PEASE, H. T. . . A note on Dourine in the horse. (*Agr. Jour. Ind. Vol. xii, 1917, p. 230.*)

" " . . . A note on an outbreak of contagious pneumonia in Donkeys. (*Agr. Jour. Ind. Vol. xii, 1917, p. 268.*)

PEARSE, L. . . Klossiella infection of the guinea pig. (*Jour. Exp. Med. Vol. xxiii, 1916, p. 431.*)

PIOT BEY . . . The immunization of Egyptian cattle against Rinderpest by the simultaneous method with serum and virulent blood. The duration of the immunity. (*Ann. de. L'Inst. Past. Vol. xxx, 1916, p. 187.*)

RADCLIFF, J. A. D. . Complement fixation in Pulmonary Tuberculosis. (*Jour. Hyg. Vol. xv, 1915-17, p. 36.*)

RAILLIET, A. . The Filaria of Reptiles. (*Bull. Soc. Path. Exot. Vol. ix, 1916, p. 137.*)

REICHEL, J. AND HARKINS, M. J. The Diagnosis of Infectious Abortion of Cattle (Bang's Disease) with special reference to the intradermal abortion test. (*Jour. Amer. Vet. Med. Assoc. Vol. l, 1916, p. 847.*)

RHEA, R. L. AND MACKIE, G. W. Some experiments with Bacterial Vaccines for the care of splenetic tick fever in cattle. (*Jour. Amer. Vet. Med. Assoc. Vol. xlix, 1916, p. 361.*)

ROBERTSON, H. E. . The prophylactic use of Tetanus Anti-toxin. (*Amer. Jour. Med. Sc. Vol. cli, 1916, p. 668.*)

ROBERTSON, H. E.	The distribution of Tetanus Toxin in the body. (*Amer. Jour. Med. Sc. Vol. clii, 1916, p. 31.*)
,, ,,	The present status of Magnes. Sulphate in the treatment of Tetanus. (*Arch. Intern. Med. Vol. xvii, 1916, p. 677.*)
RODHAIN, J. AND VAN DEN BRANDEN, F.	The susceptibility of the Flying Fox to different strains of African Trypanosomes. (*Bull. Soc. Path. Exot. Vol. ix, 1916, p. 234.*)
RODHAIN, J.	Note on the Trypanosomiasis and Piroplasmosis of large animals of the Onella district. (*Bull. Soc. Path. Exot. Vol. ix, 1916, p. 95.*)
SEN, S. K.	A preliminary note on the role of blood in Ovulation in Culicidæ. (*Ind. Jour. Med. Res. Vol. iv, 1917, p. 729.*)
SCHROEDER, E. C. AND COTTON, W. E.	Some facts about abortion disease. (*Jour. Amer. Vety. Med. Assoc. Vol. l, 1916, p. 321.*)
SHILSTON, A. W.	Sheep scab. (*Jour. Comp. Path. and Therap. Vol. xxix, 1916, p. 290.*)
SMITH, T.	Aberrant Intestinal and Protozoan Parasites in the Turkey. (*Jour. Exp. Med. Vol. xxiii, 1916, p. 293.*)
SOPARKAR, M. B.	The cultivation of the Tubercle Bacillus directly from sputum and postmortem material. (*Ind. Jour. Med. Res. Vol. iv, 1916-17, p. 28.*)
,, ,,	The vitality of the Tubercle Bacillus outside the body. (*Ind. Jour. Med. Res. Vol. iv, 1916, p. 627.*)
STUCHMER, A.	The local or primary symptoms at the seat of inoculation of rabbits inoculated with Nagana. The transition from the primary to the secondary stage. (*Zeit. F. Immunitätsforsch. I Teil Orig. Vol. xxiv, 1914, p. 315.*)
TERIN, C.	Immunity against Foot & Mouth Disease. (*Clinica Veter. Vol. xxxix, 1916, p. 257.*)
TRAUM, J.	Case reports of Lymphangitis in cattle caused by an acid-alcoholic fast organism. (*Jour. Amer. Vet. Med. Assoc. Vol. xlix, 1916, p. 254.*)
VAN SACEGHEM	The transmission of Tryp. cazalboui. (*Bull. Soc. Path. Exot. Vol. 1916, p. 569.*)
VEGLIA, F.	Anatomy and Life History of Hæmonchus contortus (Rud). (*3rd and 4th Reports Director, Veterinary Research, Dept. Agr. S.A., 1915, p. 347.*)

VÉLU, H. AND EYRAUD, R. — Equine Trypanosomiasis in Morocco. Infection of a milk-sucking pup. (*Bull. Soc. Path. Exot. Vol. ix, 1916, p. 567.*)

VÉLU, H. . . . Treatment of Epizootic Lymphangitis with Novarsenobenzol. (*Rec. de. Méd. Vét. Vol. xci, 1916, p. 152.*)

WADSWORTH, W. J. . Observations on the treatment of Fistulous Withers. (*Jour. Amer. Vet. Med. Assoc. Vol. l, 1916, p. 47.*)

WALLIS, W. . . Improvements in Bacteriological Media. A new and efficient substitute for Nutrose. (*Ind. Jour. Med. Research Vol. iv, 1917, p. 786.*)

WARD, A. R. . . The development of ideas regarding the preparation and use of anti-Rinderpest serum. (*Jour. Amer. Med. Vet. Assoc. Vol. xlix, 1916, p. 456.*)

WARE, F. . . . The possibility of Amæbic Dysentery in the Dog and its treatment with Emetin. (*Jour. Comp. Path. and Therap. Vol. xxix, 1916, p. 126.*)

WATSON, F. E. A. . Dourine and Complement Fixation Test. (*Rep. Vet. Dir.-Gen. Dept. Agr. Canada, 1915, p. 100.*)

WEHRBEIN, H. . . Paralysis of pigs. (*Jour. Amer. Vet. Med. Assoc. Vol. xlix, 1916, p. 238.*)

WILLIAMS, G. H. . Sarcoptic Mange in the Ox. (*Jour. Comp. Path. and Therap. Vol. xxx, 1917, p. 77.*)

WILIAMS, W. L. . . Researches upon Contagious Abortion in Cattle. (*Vet. Jour. Vol. lxxii, 1916, p. 367.*)

" " . . The outlook for the Control of Cattle Abortion. (*Jour. Amer. Vet. Med. Assoc. Vol. xlix, 1917, p. 199.*)

" " . . The death and expulsion of the immature fœtus as a standard for measuring the prevalence of cattle abortion. (*Journal Amer. Vet. Med. Assoc. Vol. l, 1917, p. 29.*)

" " . . Granular Vaginitis and Contagious Abortion. (*Rec. de. Med. Vet. Vol. xcii, 1916, p. 507.*)

WILLIAMS, W. W. AND BURDWICK, W. — A new culture media for the Tubercle Bacillus. (*Jour. Bacter. U. S. A. Vol. i, 1916, p. 411.*)

YAKIMOFF, W. L., SCHOKHOR, N. J., AND KOSELKINE, P. M. — Avian Spirochætosis in Russian Turkestan. (*Bull. Soc. Path. Exot. Vol. ix, 1916, p. 227.*)

YAKIMOFF, W. L. AND WASSILEWSKY, W. J. — The treatment of Camel Trypanosomiasis in Russian Turkestan. (*Bull. Soc. Path. Exot. Vol. ix, 1916, p. 230.*)

YAKIMOFF, W. L. AND SCHOKHOR, N. J. Trypanosoma theileri in Russian Turkestan. (*Bull. Path. Exot. Vol. iv, 1916, p. 229.*)

ZUNZ, E. AND DIAKONOFF, M. W. Recherches sur l'Anaphylaxie par la Diglycylglycine. (*Biochem. Jour. Vol. x, 1916, p. 160.*)

INDEX.

A

R

S

Departmental Publications.

I.—METEOROLOGICAL DEPARTMENT—

Government of India Office.

(1) The Indian Daily Weather Report and Chart.
(2) The Weekly Rainfall Summary.
(3) The Monthly Weather Review.
(4) The Annual Summary.
(5) The Rainfall of India.
(6) Indian Meteorological Memoirs.

Bengal Office.

(1) Bengal Daily Weather Report and Chart.
(2) Monthly Rainfall Tables and Summaries of the chief feature of the weather of the month over Bengal.

Bombay Office.

(1) Bombay Daily Weather Report and Chart.
(2) Monthly Abstracts of the Bombay observations (*Bombay Gazette*).

Madras Office.

(1) Bombay Daily Weather Report and Chart.
(2) Monthly Rainfall Tables (*Madras Gazette*).

Allahabad Office.

(1) Monthly Weather Summaries (*United Provinces Gazette*).
(2) Annual Summary.
(3) Monthly Rainfall Tables (*United Provinces Gazette*).

Lahore (Simla) Office.

(1) Monthly Summary } of Punjab weather.
(2) Annual Summary }

II.—GEOLOGICAL SURVEY.

The publications of the Department include—

Palæontologia Indica arranged in series, and sold in parts which are priced at 4 annas (6 pence) per plate.

Memoirs, Vols. I.—XLIII, including the larger papers on geological subjects.

Records, Vols I.—XLVIII, including the shorter papers and Annual Reports from 1868 to 1915, sold in parts, price one rupee each.

Manual, Guides and Maps.

A complete list of the contents of these publications can be obtained by application to the Registrar, Geological Survey of India, 27, Chowringhee Road, Calcutta.

Indexes to the Genera and Species described in the *Palæontologia Indica* up to 1891, to the Memoirs, Vols. I—XX, and to the Records, Vols. I—XXX have been printed for sale.

III.—SURVEY OF INDIA.

(1) Annual General Report.
(2) Professional Papers.

IV.—BOTANICAL SURVEY AND ROYAL BOTANIC GARDEN, CALCUTTA.

(1) Annual Report of the Botanical Survey of India.
(2) Records of the Botanical Survey, Vols. I—VIII.
(3) Annual Report of the Industrial Section, Indian Museum.
(4) Annual Report of the Royal Botanic Garden, Calcutta.

(5) Annals of the Royal Botanic Garden, Calcutta, Vols. I—XII.

A list of the contents of the Records and of the Annals with prices of the numbers and volumes still available can be obtained by applying to the Superintendent, Royal Botanic Garden, Calcutta.

V.—Department of Agriculture.

(1) Annual Report.—An account of the year's work of the Imperial Department, including the separate reports of the scientific officers of each branch (Agricultural Chemistry, Botany, Mycology, Entomology, and the like).

(2) The Agricultural Journal of India.—A quarterly journal containing articles on agricultural matters intended for the educated agriculturist and the general reader interested in Agriculture.

(3) Scientific Memoirs of the Department of Agriculture.—An occasional publication for papers of a scientific or technical nature divided into series such as Chemical, Botanical, Entomological, and the like.

(4) Bulletin.—An occasional publication containing information on agricultural matters of a temporary nature.

(5) Leaflets.—Short notes of practical instruction in agricultural matters, dealing mainly with entomological subjects.

VI.—Forest Department.

(1) Review of Forest Administration in British India by the Inspector-General of Forests (issued annually).

(2) Annual Progress Report of Forest Administration in each Province.—Issued by the Local Governments annually.

(3) Indian Forest Records.

(4) Indian Forest Memoirs.

(5) The Indian Forester.—A monthly Journal of Forestry, Agriculture, Shikar and Travel. This is a Departmental Journal, published monthly.

(6) Bulletins are published from time to time.

VII.—Zoological Department.

(1) The Annual Report, 8vo.

(2) The Records of the Indian Museum, 8vo. Containing short papers on Indian zoology. One or two volumes issued annually in quarterly parts.

(3) The Memoirs of the Indian Museum, 4to. Containing monographs and other important papers. Published at irregular intervals.

(4) Descriptive Catalogue of Indian Decapod Crustacea, 4to. Parts published at irregular intervals.

(5) Descriptive Catalogue of Indian Echinodermata, 4to. Parts published at irregular intervals.

VIII.—Civil Veterinary Department.

(1) Annual Report.

SGPI—No. 11 SBSA—16-3-18—850.